# QUALITY ASSURANCE PROJECT PLAN (QAPP)

# SUPPORT FOR CONDUCTING SYSTEMS AND PERFORMANCE SURVEYS OF NATIONAL ATMOSPHERIC MONITORING STATIONS

**Prepared for:**
**U. S. Environmental Protection Agency**
**Washington, DC 20460**

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**EPA Contract No.: EP-W-07-061**

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# GROUP A: PROJECT MANAGEMENT

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**List of Acronyms and Abbreviations**

| | |
|---|---|
| AIRMoN | Atmospheric Integrated Research Monitoring Network |
| CAAA | Clean Air Act Amendments |
| CAIR | Clean Air Interstate Rule |
| CAL | Central Analytical Laboratory |
| CAMR | Clean Air Mercury Rule |
| CASTNET | Clean Air Status and Trends Network |
| CAVR | Clean Air Visibility Rule |
| EEMS | Environmental, Engineering and Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSSD | Field Site Survey Database |
| GPRA | Government Performance and Results Act |
| GPS | global positioning system |
| HAL | Mercury Analytical Lab |
| Hg | mercury |
| ISWS | Illinois State Water Survey |
| MDN | Mercury Deposition Network |
| NADP | National Atmospheric Deposition Program |
| NIST | National Institute of Standards and Technology |
| NOS | Network Operations Subcommittee |
| $NO_x$ | nitrogen oxides |
| NTN | National Trends Network |
| NWS | National Weather Service |
| OAP | Office of Atmospheric Programs |
| OTC | Ozone Transport Commission |
| PART | Program Assessment Rating Tool |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |

**List of Acronyms and Abbreviations (continued)**

| | |
|---|---|
| QC | quality control |
| QMP | quality management plan |
| SIP | state implantation plan |
| $SO_2$ | sulfur dioxide |
| SOP | standard operating procedures |
| µS/cm | micro Siemens/centimeter |

# A3 Distribution List

Copies of the approved document "Quality Assurance Project Plan (QAPP) for Conducting Systems and Performance Surveys of National Atmospheric Monitoring Stations", along with any subsequent revisions, are distributed to the persons listed below:

| | |
|---|---|
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# 1.0 GROUP A: Project Management Elements

This Quality Assurance Project Plan (QAPP) has been prepared to meet the requirement of the Environmental Protection Agency (EPA) Contract Number EP-W-07-061, for the Support for Conducting Systems and Performance Surveys of National Atmospheric Monitoring Stations (from this point on referred to as the NADP Site Survey Program). This QAPP describes the objectives of the surveying activities to be performed at National Atmospheric Deposition Program (NADP) sites, data quality requirements and assessments, project management, organization and responsibilities of Environmental Engineering & Measurement Services, Inc. (EEMS) staff and consultants, and a schedule of activities and deliverables. This QAPP has been prepared compliant with EPA Order 5360.0 A2, *Policy and Program Requirements for the Mandatory Agency-wide Quality Systems* and with the EPA QAPP format as presented in the *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R5 (EPA 2001).

## 1.1 A1 – Title and Approval Sheet

Title and Approval Sheet provided in preliminary section of this document.

## 1.2 A2 – Table of Contents

Table of Contents provided in preliminary section of this document.

## 1.3 A3 – Distribution List

Distribution List provided in preliminary section of this document.

## 1.4 A4 – Project/Task Organization

The NADP Site Survey Program is fundamentally a quality assurance role to ensure the reliability of data collected at these sites. This includes a thorough, on-site evaluation of facilities, equipment, personnel, training, procedures, documentation and reporting aspects of the field operations systems. Field systems survey results are used to ensure that good quality assurance/quality control (QA/QC) practices are being applied as defined in the NADP Quality Management Plan (QMP). The individuals with major responsibilities participating in this project are presented below.

<u>EEMS Project Manager</u>

The project manager is responsible for:

- Coordinating with the surveyor regarding survey schedules, procedures, standards and constants, and required supplies.

- Reviewing all survey results.
- Distributing the survey results to designated personnel in a timely fashion.
- Reviewing and approving any changes to the survey procedures.
- Preparing and maintaining the QAPP.
- Assisting in preparing the template for the surveying activities (Site Performance Survey Questionnaire).
- Coordinating survey schedules with the Survey Team Leader.
- Notifying the applicable personnel of any upcoming surveys.
- Reviewing and forwarding the survey deliverables to the applicable personnel.
- Preparing Monthly Technical Progress reports to the U.S. EPA.
- Preparing an Annual Summary Report to the U.S. EPA.
- Attending annual NADP meetings.

The EEMS Project Manager is Maria Jones, P.E.

EEMS Survey Team Leader

The Survey Team Leader is responsible for:

- Coordinating with the Project Manager regarding survey schedules, survey procedures, accuracy goals, required materials, and survey standards.
- Performing all required surveys in accordance with approved survey protocols as described in the specific Standard Operating Procedure (SOP).
- Maintaining all survey standards.
- Meeting with, observing and/or interviewing the site operators as needed during surveys.
- Documenting the survey results using the appropriate forms and database.
- Preparing and forwarding survey reports to the Project Manager.
- Assisting in preparing the QAPP.
- Assisting in preparing the template for the surveying activities (Site Performance Survey Questionnaire).
- Acquiring the appropriate equipment, supplies and standards to conduct the surveys
- Training other EEMS employees, or EEMS consultants (Survey Technicians) who may be expected to perform surveys.
- Finalizing and forwarding the survey deliverables to the EEMS Project Manager.
- Attending annual NADP meetings.

The EEMS Survey Team Leader is Eric Hebert.

EEMS QA Manager

The QA Manager is responsible for:

- The review and approval of the QAPP.
- Document control.
- QC of database entries.
- Overseeing the maintenance of National Institute of Standards and Technology (NIST) traceable records and survey standards.
- The review all deliverables (including the QAPP) to the U.S. EPA and the NADP PO to ensure that these deliverables are of the type and quality required for their intended use.

The EEMS QA Manager is Keith Halbrook.

U.S. EPA Project Officer

The functions of the U.S. EPA Project Officer are:

- Providing overall technical direction for the project.
- Receiving notification of EEMS' activities on the project
- Receiving all EEMS' survey deliverables.

The U.S. EPA Project Officer is Michael Kolian, and the alternate is Melissa Rury.

U.S. EPA QA Officer

The functions of the U.S. EPA QA Officer are:

- Reviewing all deliverables (including the QAPP) to ensure that these deliverables are of the type and quality required for the intended use.

The U.S. EPA QA Officer is Larry Ketcher.

NADP QA Manager

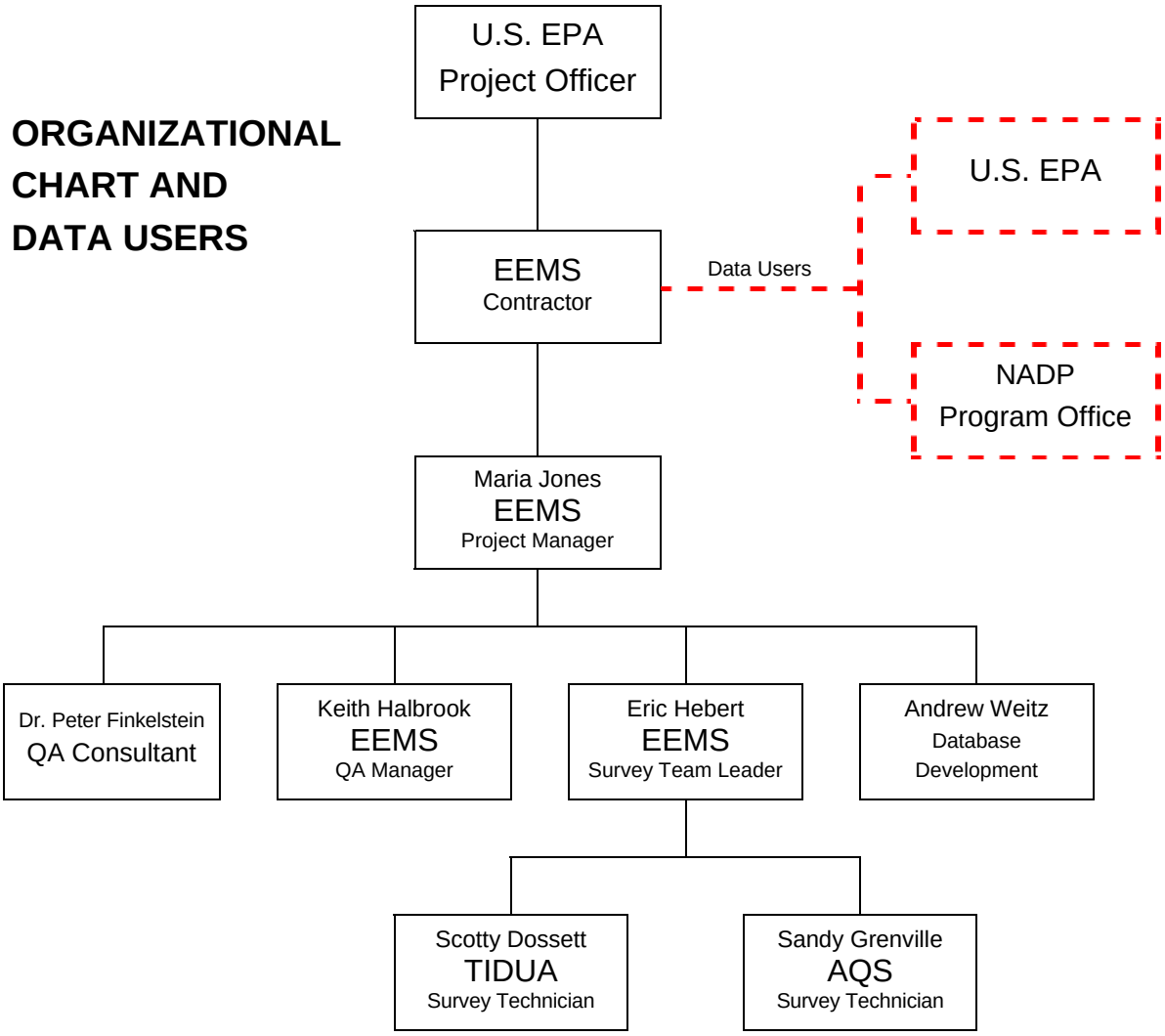
The functions of the NADP QA Manager are:

- Reviewing all deliverables to the NADP Program Office to ensure that these deliverables are of the type and quality required for the intended use.
- Assisting in preparing the template for the surveying activities (Site Performance Survey Questionnaire).
- Receiving all survey deliverables.

The NADP QA Coordinator is Mark Rhodes.

Figure 1 shows the organizational chart for EEMS with the relationships and lines of communication among the project participants, together with the users of the data generated by this survey program.

**Figure 1. Organizational Chart and Data Users**


ORGANIZATIONAL CHART AND DATA USERS
U.S. EPA Project Officer
EEMS Contractor
Data Users
U.S. EPA
NADP Program Office
Maria Jones EEMS Project Manager
Dr. Peter Finkelstein QA Consultant
Keith Halbrook EEMS QA Manager
Eric Hebert EEMS Survey Team Leader
Andrew Weitz Database Development
Scotty Dossett TIDUA Survey Technician
Sandy Grenville AQS Survey Technician

## 1.5 A5 – Problem Definition/Background

The Acid Rain Program, established under Title IV of the 1990 Clean Air Act Amendments (CAAA), requires major reductions of sulfur dioxide ($SO_2$) and nitrogen oxides ($NO_x$) emissions from the electric power industry. Similarly, other programs such as the Ozone Transport Commission (OTC), $NO_x$ Budget Trading Program and the EPA's $NO_x$ State Implementation Plan (SIP), both of which are seasonal and regional $NO_x$ reduction programs also require emissions reductions from the power sector. In the spring of 2005, EPA promulgated a suite of air quality rules designed to further the reductions of $SO_2$ and $NO_x$, as well as mercury (Hg) emissions from power plants. These new rules include the Clean Air Interstate Rule (CAIR), the Clean Air Mercury Rule (CAMR), and the Clean Air Visibility Rule (CAVR). Assessing the environmental impacts of power generation such as regional air quality and atmospheric deposition of sulfur, nitrogen, and mercury is important to understanding and evaluating the progress of these emission reduction programs. EPA adheres to several mandates such as Title IX of the Clean Air Act, the Government Performance and Results Act (GPRA), and the Program Assessment Rating Tool (PART) to report on the performance and overall progress of these programs. This involves evaluating the environmental effectiveness of these programs as measured by a variety of environmental monitoring efforts at different scales, and examination of the link between emissions and atmospheric concentrations, deposition, and soil/aquatic chemistry and biological impact, and between concentration levels and human health. EPA's air quality management strategy must continue and improve tracking regional patterns of pollutant concentrations, transport, and trends.

To understand the impact of emissions reductions on the environment, scientists and policy makers use data collected from long-term national monitoring networks such as the Clean Air Status and Trends Network (CASTNET) and the NADP. These networks are complementary in many ways and provide information on a variety of indicators necessary for tracking temporal and spatial trends in regional air quality and atmospheric deposition. EPA provides support to the NADP, a cooperative, multi-agency network, which measures precipitation chemistry and estimates atmospheric deposition for various pollutant ions and mercury. EPA has provided long-standing support for the operation of NADP. In addition to operational support, EPA provides support for the survey and quality assurance programs of the NADP networks. Contract Number EP-W-07-061 provides for the survey and quality assurance assessment of sites associated with the three inter-related NADP networks–the National Trends Network (NTN), the Atmospheric Integrated Research Monitoring Network (AIRMoN), and the Mercury Deposition Network (MDN). Surveys of sites under this contract will provide the necessary checks and balances for the site operations and will serve to validate data provided by the sites in the network.

QA/QC activities for these networks improve overall data quality and ensure field measurements remain accurate and precise. Stringent QA and QC are essential for obtaining unbiased and representative atmospheric deposition measurements and for maintaining the integrity of the sample during collection, handling, and analysis. These activities strengthen the reliability and overall quality of the data the EPA uses for policy decisions and for measures of accountability.

## 1.6 A6 – Project/Task Description

The work to be performed under this contract involves support to the EPA, Office of Atmospheric Programs (OAP). Under this contract EEMS performs a survey of site operations for NADP's atmospheric deposition collection networks. All results are recorded in a relational database and reported to the relevant data users. The surveys provide quality assurance pertaining to siting, sample collection and handling, equipment operation and maintenance, record keeping, reports, and field laboratory procedures.

### 1.6.1 A6.1 Work to be Performed

The primary function of this contract is to provide in-field systems and performance survey services (herein after referred to as surveys) to assess and aid the performance and maintenance of the nationwide, long-term wet deposition monitoring networks of the NADP.

NADP collection stations are currently comprised of three networks which include: precipitation chemistry and wet deposition sites in the NTN; precipitation chemistry and wet deposition sites in the AIRMoN; and measurements of mercury concentrations in precipitation at wet deposition sites in the MDN.

There are currently over 250 wet deposition sites in the NADP/NTN, over 90 sites in the NADP/MDN, including over 40 that are collocated at NTN sites, and 7 sites in NADP/AIRMoN, including three that are collocated at NTN sites. NADP operates sites throughout the continental United States, Alaska, Canada, Mexico, Puerto Rico, and U.S. Virgin Islands. Current maps with the sites for the three different networks can be found at http://nadp.sws.uiuc.edu. The number of sites in each network can vary at any given time and is expected to increase. EEMS will be responsible for maintaining a current inventory of sites, based on information provided by the NADP PO, located at the Illinois State Water Survey (ISWS).

The NADP PO operates and/or administers the three precipitation chemistry networks (NTN, AIRMoN, and MDN), two analytical laboratories, and the Network Equipment Depot (NED). Each network has a particular objective and corresponding sampling analytes and periods.

### 1.6.2 A6.2 Work Performed Prior to Initiating Performance Surveys

EEMS attended an operations workshop sponsored by the NADP PO at the ISWS prior to initiating performance surveys. The purpose of this workshop was to provide the necessary orientation to EEMS, on the various operations of the NADP PO, as well as to provide directions on network equipment and procedures to assist in implementing the site survey program. This workshop also allowed for the development of a template for the database which contains survey information collected for each network (from this point on referred to as the Site Performance Survey Questionnaire and can be found in Appendix B). Specific site survey procedures for each network, as well as quality assurance and the transfer of survey data to the NADP PO and the EPA procedures were developed with the cooperation of the NADP PO.

The workshop was conducted August 7 and 8, 2007. It was attended by EEMS personnel (Project Manager, Survey Team Leader, and QA Manager), along with two EEMS consultants, EPA's project officer representative, representatives from each of the three networks, Central Analytical Laboratory (CAL), Mercury Analytical Lab (HAL) and the former NADP QA Manager. This schedule was in conformance with the Statement of Work for this project, which required that the workshop be conducted within the first ninety days of contract award.

### 1.6.3 A6.3 Participation in NADP's Standing Subcommittee on Network Operations

Appropriate representatives from EEMS will actively participate on NADP's standing Subcommittee on Network Operations (NOS) meeting twice a year. EEMS representatives will also attend the Annual Technical Committee Meetings and any other interim business meetings as appropriate.

### 1.6.4 A6.4 Site Systems and Performance Surveys

EEMS will conduct surveys of approximately 90 sites per year from the NADP NTN, AIRMoN, and MDN networks, including collocated sites. A monitoring site can have one or more collocated NADP collection stations at a single site location. Collocated sites include those sites that are within a 1 km radius. Each approved NADP monitoring station at the physical location will be considered a single monitoring station in the total for the year. The purpose of the surveys is to provide an independent quality assurance assessment of all NADP sites, documenting the conditions of the site, site operations, and site equipment. The survey team will conduct external quality assurance evaluations pertaining to NADP approved siting criteria, sample collection and handling, field measurement procedures and SOPs, equipment operation and maintenance, record keeping, reports and field laboratory procedures. As part of the site survey, EEMS will also perform minor repairs and preventive maintenance, and will assist in restoring proper function to site equipment. Surveys may also include certain other monitoring activities and special studies located at approved NADP sites using approved NADP monitoring equipment. In such cases,

EEMS will contact the NADP PO and the EPA Project Officer to verify whether a survey is applicable.

The items in the Site Performance Survey Questionnaire for each network will be checked at each collection site and entered into a computer database maintained by EEMS. This database will ensure and verify the validity of all entries. Database reports and tables will be electronically transferred to the EPA and NADP QA Manager. The database files will be in Microsoft Access® format and contain every item on the network Site Performance Survey Questionnaire. Digital site images will be provided in electronic format with a consistent, site specific naming convention. Additional survey documentation will be mailed to the EPA Project Officer and the NADP QA Manager. EEMS will develop a site survey procedures manual or SOPs that details the major functions and procedures involved in conducting a site survey as part of this program. The NADP anticipates changes to equipment and procedures during the period of this contract. Such changes, when approved by the NADP PO and subcommittees, are considered within the scope of Contract Number EP-W-07-061.

The following tasks pertain to general preparation for conducting surveys at NADP monitoring sites.

### 1.6.5 A6.5 Work to be Performed in Preparation for Conducting Surveys

EEMS will become familiar with the overall operations of each of the three NADP networks, and will work closely with the NADP PO in the coordination of site surveys and to maximize the utility of information gathered.

Standards and supplies required to conduct the survey will include:

- Standard weights for calibrating rain gages,
- Global Positioning System (GPS) device equipped with a Wide Area Augmentation System (WAAS). Survey quality compass (NIST certified) for accurate proximity determinations of site equipment and site configuration purposes.
- At a minimum 4.0 mega pixel digital camera,
- Field-suitable laptop computer with Microsoft Access 2003, or later version,
- Quality control check samples and conductivity standards, as appropriate, provided by CAL.
- EEMS understands that in the event that the NADP updates site equipment over the period of this contract, EEMS may be required to procure additional equipment to verify calibration of new NADP-approved equipment.

EEMS will initiate communications with the NADP representatives and site liaisons at the CAL, HAL and NADP QA Manager to obtain an update of the site status, and site operator information prior to initiating site surveys. Upon receiving updates of the status of the sites, EEMS will proceed to develop a proposed schedule of sites to be surveyed in the first year of this contract based on historical survey data.

EEMS will develop a database that will provide the EEMS team with electronic entry forms for inputting and handling information collected from the site surveys. This will include documentation on all equipment and major features within the 30 meter radius of the NADP collector. The database will be able to store historical information from previous surveys so data entry/exit rules can be written that will challenge entries that differ significantly from initial entries. This database will then generate an abbreviated exit report (Spot Report) from the preliminary numeric audit results and written findings. The Spot Report will include findings that could result in data invalidation. Further information on this database is provided the NTN Site Performance Survey Standard Operating Procedures – SOP-EPW07061-1010.

During the first 90 days of this contract, EEMS developed a Quality Management Plan (QMP) according to EPA Requirements for Quality Management Plans (EPA QA/R-2) and this QAPP which conforms to EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5).

### 1.6.6 A6.6 Work to be Performed During the Remaining One-Year Base Period and Each One-Year Option Period

EEMS will conduct surveys of approximately 90 monitoring sites each year. The first consideration will be given to those sites that have not been surveyed for three or more years. Following this criteria, EEMS will develop a schedule of the sites to be surveyed during the remaining one-year base period.

#### 1.6.6.1 Prepare for Each Survey Trip

One month before the scheduled site survey, EEMS will contact the EPA Project Officer, the NADP PO QA Manager, the appropriate site liaisons and site operator and supervisor to establish an agenda for the survey. Details pertaining to the contacting procedures can be found in SOP-EPW07061-1010. EEMS will also prepare the necessary supplies to conduct the site surveys. These supplies comprise the Site Survey Kit, and will comply with NOS-approved specifications. Equipment repaired and/or calibrated on site by EEMS will be in accordance with NOS-approved procedures. EEMS will compile the necessary information in preparation for the site survey, and will generate the necessary field forms to conduct the survey. This subject is further discussed in Section B3 – Data Handling and Custody.

#### 1.6.6.2 Conduct Site Surveys

Survey Technicians will meet the site operator and other interested parties as prearranged, and will conduct the survey in accordance with the SOPs included in Appendix A. These SOPs have been developed by EEMS for the different aspects of conducting the survey. Assistance from the site operator will only be required to obtain the information necessary to complete the Site Performance Survey Questionnaire that pertains to the historical data and to the evaluation of his or her sample handling techniques.

EEMS will conduct a quantitative performance assessment during the surveys. All information will be recorded by EEMS in the Site Performance Survey Questionnaire forms.

#### 1.6.6.3 Prepare and Forward Survey Deliverables

Within 24 hours of completion of the site survey, EEMS' Survey Technician will generate a Spot Report that will include any immediate action items necessary to restore proper function to the site. It will contain a summary of survey activities and serve to document the visit. The Survey Technician will verbally brief the supervisor and operator on the results of the systems and performance survey.

The Site Performance Survey Report will be prepared and submitted in electronic format within 15 days after completion of the site survey.

#### 1.6.6.4 Prepare Monthly Progress Reports

EEMS Project Manager will prepare written technical progress reports (Monthly Progress Report) that will include the following items:

- A summary of EEMS' activities conducted during the reporting period
- A summary of EEMS' activities currently scheduled during the next reporting period
- A listing of outstanding actions awaiting EPA Project Officer authorization

Two copies of the Monthly Progress Report will be submitted to the EPA by the 10$^{th}$ day of each month: one to the EPA Project Officer and one to the Contract Specialist.

#### 1.6.6.5 Prepare Annual Summary Report

EEMS Project Manager will prepare a written draft report summarizing EEMS' surveying activities and findings. The report will include the sites surveyed during each calendar year. Two copies of the draft will be prepared and submitted by EEMS: one to the EPA Project Officer, and one to the NADP QA Manager. The draft report will be submitted within 90 days following each calendar year or in sufficient time for the annual NADP interim subcommittee meeting. The EPA Project Officer will have up to 45 days for review, comment, and return of the report. Five

copies of the final report will be prepared and submitted by EEMS to the EPA Project Officer within 30 days after approval of the report.

#### 1.6.6.6 Semi-Annual NADP Meetings

EEMS Project Manager and Survey Team Leader (or representatives) will attend the Annual Interim Subcommittee meeting (typically scheduled during the spring months) and actively participate on the NADP NOS. EEMS Project Manager and Survey Team Leader (or representatives) will attend the annual NADP Technical Committee interim meeting (typically scheduled during the autumn months). A brief update of EEMS' recent activities will be presented at both meetings. The EPA Project Officer and the NADP QA Manager shall provide updates and summaries as appropriate to NADP members. A summary of the results included in the annual summary report will be presented at the Annual NADP Interim Subcommittee Meeting.

#### 1.6.6.7 Maintaining the QAPP

EEMS Project Manager will periodically review the QAPP for accuracy. The review will occur upon major changes in procedures or personnel, or at least annually, whichever is sooner. The initial hard copy QAPP document will be presented in a three-ring binder. Approved revision pages and instructions for removal of old pages and insertion of new pages will be forwarded to those included in the document distribution list.

## 1.7 A7 – Quality Objectives and Criteria

The intent of the NADP Site Survey Program is to provide an unbiased assessment for all NADP sites and to document the results to verify that all evaluated parameters are consistent with the NADP performance and accuracy goals. The quality objectives of this survey program are to evaluate the parameters in a precise manner and to accurately report the findings.

### 1.7.1 A7.1 Project Quality Objectives

The project quality objective is to ensure that the survey data collected by EEMS are of the type and quality required by the EPA and the NADP PO to determine if the samples and field data collected at each network site are in conformance with NADP QAPP. The project objective will be satisfied by:

- EEMS and the end users jointly developing the Site Performance Survey Questionnaire for gathering, recording and transmitting the data at the operations workshop
- Establishing regular communications between EEMS Survey Team Leader and NADP representatives (typically the NADP QA Manager and NADP network site liaisons).

Quality objectives will continue to be developed within the scope of this project.

### 1.7.2 A7.2 Measurement Performance Criteria

Historical data available from previous site surveys will be entered into the Site Performance Survey Questionnaire for the upcoming surveys. Where possible, all historical data will be checked by EEMS during the survey to verify if changes have occurred. Changes may be likely given that sites are surveyed approximately once every three years and that sites are dynamic in terms of the performance of the site operators, the performance of the equipment, and site surroundings.

EEMS' goal is to obtain 100 percent data completeness of the Site Performance Survey Questionnaire. Difficulties in accomplishing this goal may include such factors as inclement weather during the survey, non-participation of the site operator during the survey, unexpected failure of any of EEMS' measurement equipment, and other factors beyond EEMS' control. EEMS expects to obtain an overall data completeness of the Site Performance Survey Report of at least 95 percent.

## 1.8 A8 – Special Training/Certification

No special training or certifications are required of EEMS personnel and its consultants assigned to participate in this project. EEMS personnel that will be participating in field activities and EEMS' consultants attended the Project Operations workshop as required by Contract Number EP-W-07-061. EEMS personnel and its consultants have extensive experience performing field survey activities.

Training of all new field personnel will be provided by the Survey Team Leader. All new field personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

The EEMS QA Manager will observe the survey Team's procedures and techniques at various sites during NADP surveys. The QA Manager will provide a report regarding the proficiency of the Survey Technicians within on month of the observation (or field audit).

## 1.9 A9 – Documents and Records

During the course of this project the following documents and records will be generated and revised as needed:

- The current QAPP and subsequent revisions
- The Site Performance Survey Questionnaire
- Survey announcement letters to the site operator, site supervisor and site sponsor

- Field Data Sheets of the Site Performance Questionnaire for data gathering (individual SOPs)
- Survey deliverables
- Monthly Progress Reports
- Annual Summary Reports
- Site Survey File
- Any other formal written correspondence from the EEMS Project Manager to the EPA Project Officer or the NADP QA Manager.

The EEMS QA Manager is responsible for review of and maintaining the distribution of the current version of the SOPs and QAPP.

Table 1 includes the different types of reports, generated for the NADP Site Survey Program, the recipient of each report and the level of detail.

**Table 1. Documents Generated for the NADP Site Survey Program**

| Report Name | Recipients | Purpose and Description |
|---|---|---|
| Field SOPs | EPA Project Officer ;<br>NADP QA Manager | Describes the procedures to follow when conducting all aspects of the site surveys |
| QAPP and Subsequent Revisions | EPA Project Officer | Documentation of all aspects of QA/QC to be followed during the period of this contract |
| Site survey announcement correspondence | Site supervisor;<br>site operator and<br>EPA Project Officer | Letter confirming date, time and location of the scheduled site survey along with a brief agenda and duration of the site survey |
| Survey Deliverable: Spot Report | Site Personnel;<br>Site Liaisons;<br>NADP QA Manager;<br>EPA Project Officer | Report of site activities and items requiring repair and maintenance |
| Survey Deliverable: Site Survey Performance Report | NADP QA Manager;<br>EPA Project Officer ;<br>Contract Specialist* | QC checked site survey report with all the information gathered during the site survey |
| Survey Deliverable: Monthly Progress Report | EPA Project Officer<br>Contract Specialist | Report of the previous month's activities and planned activities for the following month |

| Report Name | Recipients | Purpose and Description |
|---|---|---|
| Survey Deliverable: Annual Summary Report | EPA Project Officer ; NADP QA Manager;<br>EPA Project Officer Contract Specialist* | Summary of previous year's activities (Draft)<br>Summary of previous year's activities (Final) |
| Database Report Submitted with Monthly Progress Report | EPA Project Officer ; NADP QA Manager | Electronic database file delivery |
| * Letter of Transmittal only | | |

# 2.0 GROUP B: Data Generation and Acquisition

This section addresses all aspects of data acquisition to ensure that appropriate methods of data collection, data handling, and QC activities are being followed.

## 2.1 B1 – Data Collection Design

The NADP Site Survey Program is an external QA and maintenance function of sites within the three networks of the NADP. The design, location, acceptance, and operation of the sites within the networks are the responsibility of the NADP PO and subcommittees.

The NADP Site Survey Program is designed to test and assess each of the measurement and sample collection devices at all of the sites in the NADP. The locations of the sites can be found at www.nadp.sws.uiuc.edu.

The schedule of site surveys will be established to enable each site in the NADP to be surveyed once approximately every three years. The current Site Survey Schedule can be found at FTP://67.192.214.230.

The sites are comprised of instruments and equipment that have been approved by the NADP PO and subcommittees. Table 2 summarizes the instruments and equipment operated by the networks of the NADP and those used during the survey procedures to assess the operation of the equipment.

**Table 2. Standard Instruments and Equipment**

| Site Instrument | Network | | | Survey Standards, Instruments and Tools |
|---|---|---|---|---|
| | NTN | MDN | AIRMoN | |
| Belfort Precipitation Gage | × | × | | Weights, Linearity Tool |
| ETI NOAH IV Precipitation Gage | × | × | | Weights, PDA, Voltmeter |
| OTT NADP Pluvio Precipitation Gage | × | × | | Weights, PDA, Voltmeter |
| NWS Stick Precipitation Gage | | | × | Volumetric Flask |
| ACM Precipitation Collector | × | × | × | Temperature Probe, Weights, Voltmeter |
| N-CON Precipitation Collector | | × | | Temperature Probe, Voltmeter |
| Ohaus Balance | × | × | × | Weights |
| Scales (various) | × | | × | Weights |

| Site Instrument | Network | | | Survey Standards, Instruments and Tools | |
|---|---|---|---|---|---|
| | NTN | MDN | AIRMoN | | |
| pH meter (various) | | | × | Solution | pH: 4.01, 7.00, 10.00 |
| Conductivity meter (various) | | | × | Solution | 88, 447, 1413 (µS/cm) |

Other operational aspects of the sites are also assessed. Those include the siting criteria and operational procedures and are considered site systems surveys. The design and methods used for the assessment of all aspects of NADP site operations are described in the following sections.

## 2.2 B2 – Data Collection Methods

A performance survey and a system survey comprise the elements of a NADP site survey. When performing the site surveys, and collecting data, EEMS will follow specific SOPs developed for each aspect of the survey and instrument. As the SOPs are followed, findings are recorded in the forms that constitute the Site Performance Survey Questionnaire. The Site Performance Survey Questionnaire can be found in Appendix B. The SOPs can be found in Appendix A.

### 2.2.1 B2.2.1 – Performance Survey Procedures SOPs

EEMS developed three SOPs where the overall or general procedures for conducting the performance survey for sites in each of the three networks are specified:

- NTN Site Performance Survey Standard Operating Procedures – SOP-EPW07061-1010
- MDN Site Performance Survey Standard Operating Procedures – SOP-EPW07061-1020
- AIRMoN Site Performance Survey Standard Operating Procedures – SOP-EPW07061-1030

The performance survey procedures include verifying that sensors and gages are capable of making valid and accurate measurements as defined in the NADP QAPP, performing maintenance and calibration on the equipment as required, evaluating field laboratory performance, documenting survey results using appropriate forms and database, and distributing the survey results to designated project personnel.

EEMS developed SOPs for conducting surveys of the different types of precipitation gages found at NADP sites:

- Belfort Precipitation Gage – SOP-EPW07061-1400
- OTT NADP Pluvio Precipitation Gage – SOP-EPW07061-1410
- ETI NOAH IV Precipitation Gage – SOP-EPW07061-1420

- National Weather Service (NWS) Stick Precipitation Gage – SOP-EPW07061-1430

EEMS will check the response of the gages as found over the range appropriate for the gage, and will attempt to repair and recalibrate any Belfort gage in which the difference between the applied depth and recorded depth is out of tolerance as defined in the NADP QAPP. Stick gages and electronic gages will not be adjusted.
EEMS developed SOPs for conducting surveys of the different types of precipitation collectors found at NADP sites, including the collector sensor and motorbox:

- ACM NTN and AIRMoN Precipitation Collector – SOP-EPW07061-1310
- ACM MDN Precipitation Collector – SOP-EPW07061-1320
- N-CON Precipitation Collector – SOP-EPW07061-1330

EEMS developed SOPs for conducting surveys of the field laboratory activities, equipment and supplies found at NTN and AIRMoN NADP sites:

- Ohaus Balance (or electronic scale) – SOP-EPW07061-1210
- pH Meter – SOP-EPW07061-1220
- Conductivity Meter – SOP-EPW07061-1230

Field laboratory includes data that pertains to performance of the field laboratory equipment (bucket balance, pH measurement system and specific conductance measurement system), the inventory of supplies and recordkeeping by the site operator.

For AIRMoN sites, CAL will provide EEMS with a simulated rain sample of known pH and specific conductance. EEMS will request from the site operator that he or she analyze the sample as though it were a regular weekly sample. EEMS will be able to assess the procedures executed by the site operator in completing this task.

The methods developed and described in the performance survey SOPs are intended to be used to determine and ensure that data collected and recorded by the NADP conforms to the performance acceptance criteria established in the NADP QAPP. Table 3 is a summary of these performance acceptance criteria.

**Table 3. Performance Acceptance Criteria**

| Site Measurement | Survey Method | Acceptance Criteria |
|---|---|---|
| Belfort Precipitation Depth | Standard weight | ± 0.10 in |
| ETI Precipitation Depth | Standard weight | 0.05 in |
| OTT NADP Pluvio Precipitation Depth | Standard weight | 0.05 in |
| Stick Precipitation Depth | Standard volumetric addition | 0.01 in |

| Site Measurement | Survey Method | Acceptance Criteria |
|---|---|---|
| Collector Clutch | Weight lift | 2 standard weights |
| Mass | Standard weight | 0.5% |
| pH | Reference solution | 5.16 +/- 0.1 |
| Conductivity | Reference solution | 3.8 +/- 0.3 uS/cm |
| Precipitation Sensor Temperature | Standard temperature probe | 60 °C ± 10% in 10 minutes |

### 2.2.2 B2.2.2 – NADP Systems Survey Procedures

The NADP Systems Survey Procedures include data that pertains primarily to those aspects of the survey that are not instrument specific such as general site information, siting criteria, power source for the site, field laboratory and site operator evaluation and training. EEMS will follow SOP-EPW07061-1500 when performing this part of the survey.

EEMS will update the site sketch with a 30-meter radius footprint centered at the precipitation collector. EEMS will take electronic photographs of the site in standard Windows JPG format at a resolution not less than 4.0 mega pixels. The 8 cardinal directions N, NE, E, SE, S, SW, W, and NW will be photographed as viewed from a distance of 5 to 10 meters from the precipitation collector, with a directional badge indicating the direction of the photo. Additional views may also be taken if deemed by the Survey Technician to be necessary to adequately show the site.
EEMS will use a GPS system for measuring latitude, longitude, and elevation of the site precipitation collector for each site location.

The methods developed and described in the system SOP are intended to be used to determine and ensure that data collected and recorded by the NADP conforms to the system acceptance criteria established in the NADP QAPP. Table 4 is a summary of system acceptance criteria.

**Table 4. Systems Acceptance Criteria**

| Site Measurement | Survey Method | Acceptance Criteria |
|---|---|---|
| Collector wet bucket oriented magnetic West | Certified compass | ± 45 degrees |
| Collector and gage inlet height separation | Distance measuring device | ± 0.3 m |
| Verify site sketch | Certified compass and range finder | All objects within a 30 meter radius |

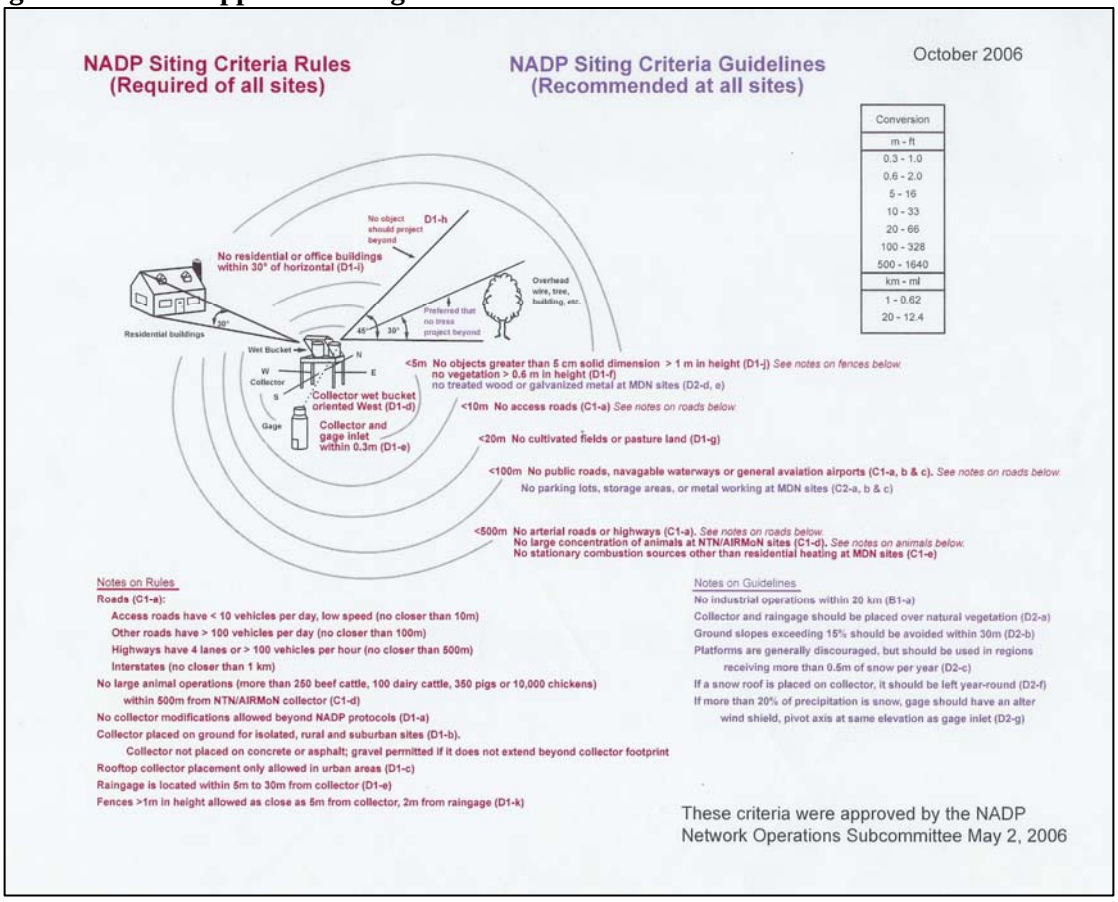
While updating the 30-meter radius site sketch, EEMS will prepare a table with that will include all the objects located within the 30-meter radius with the appropriate direction, distance from the

precipitation collector, and dimensions of the object. Table 5 shows the headers that will comprise the site sketch table. Figure 2 shows the approved NADP siting criteria.

**Table 5. Site Sketch Table**

| Direction (degrees) | Distance (meters) | Object Descriptions | Object Height (meters) | Object Width (meters) |
|---|---|---|---|---|
| | | | | |
| | | | | |

**Figure 2. NADP Approved Siting Criteria**


NADP Siting Criteria Rules
(Required of all sites)
NADP Siting Criteria Guidelines
(Recommended at all sites)
October 2006
Conversion
m - ft
0.3 - 1.0
0.6 - 2.0
5 - 16
10 - 33
20 - 66
100 - 328
500 - 1640
km - mi
1 - 0.62
20 - 12.4
No object should project beyond
D1-h
No residential or office buildings within 30° of horizontal (D1-i)
Overhead wire, tree, building, etc.
Preferred that no trees project beyond
Residential buildings
30°
45°
30°
Wet Bucket
N
W
E
S
Collector
Collector wet bucket oriented West (D1-d)
Gage
Collector and gage inlet within 0.3m (D1-e)
<5m No objects greater than 5 cm solid dimension > 1 m in height (D1-j) See notes on fences below.
no vegetation > 0.6 m in height (D1-f)
no treated wood or galvanized metal at MDN sites (D2-d, e)
<10m No access roads (C1-a) See notes on roads below.
<20m No cultivated fields or pasture land (D1-g)
<100m No public roads, navagable waterways or general avaiation airports (C1-a, b & c). See notes on roads below.
No parking lots, storage areas, or metal working at MDN sites (C2-a, b & c)
<500m No arterial roads or highways (C1-a). See notes on roads below.
No large concentration of animals at NTN/AIRMoN sites (C1-d). See notes on animals below.
No stationary combustion sources other than residential heating at MDN sites (C1-e)
Notes on Rules
Roads (C1-a):
Access roads have < 10 vehicles per day, low speed (no closer than 10m)
Other roads have > 100 vehicles per day (no closer than 100m)
Highways have 4 lanes or > 100 vehicles per hour (no closer than 500m)
Interstates (no closer than 1 km)
No large animal operations (more than 250 beef cattle, 100 dairy cattle, 350 pigs or 10,000 chickens)
within 500m from NTN/AIRMoN collector (C1-d)
No collector modifications allowed beyond NADP protocols (D1-a)
Collector placed on ground for isolated, rural and suburban sites (D1-b).
Collector not placed on concrete or asphalt; gravel permitted if it does not extend beyond collector footprint
Rooftop collector placement only allowed in urban areas (D1-c)
Raingage is located within 5m to 30m from collector (D1-e)
Fences >1m in height allowed as close as 5m from collector, 2m from raingage (D1-k)
Notes on Guidelines
No industrial operations within 20 km (B1-a)
Collector and raingage should be placed over natural vegetation (D2-a)
Ground slopes exceeding 15% should be avoided within 30m (D2-b)
Platforms are generally discouraged, but should be used in regions
receiving more than 0.5m of snow per year (D2-c)
If a snow roof is placed on collector, it should be left year-round (D2-f)
If more than 20% of precipitation is snow, gage should have an alter
wind shield, pivot axis at same elevation as gage inlet (D2-g)
These criteria were approved by the NADP
Network Operations Subcommittee May 2, 2006

## 2.3 B3 – Data Handling and Custody

As a site survey is scheduled, EEMS will request from the NADP PO all available data collected from the previous site survey and any other site information. EEMS will also request from the site personnel any information on modifications that may have been performed on the site

instrumentation, and any operational problems that may exist at the site. This preliminary information will be entered or imported into the relational Field Site Survey Database (FSSD). At this point a backup of the database will be created. EEMS will then start compiling the Site Survey File. Detail information regarding the Site Survey File can be found in site performance SOPs for the different networks (documents SOP-EPW07061-1010, SOP-EPW07061-1020, and SOP-EPW07061-1030).

A Site Survey Kit with all the materials and supplies required to perform site surveys in a planned trip will then be assembled. A copy of the Site Survey File is included as part of the kit. EEMS QA Manager oversees that the Site Survey Kit is complete and shipped to the Survey Technician responsible for performing the site survey. Upon receiving the Site Survey Kit, the Survey Technician will inspect the kit and report any missing or damaged items. Replacements will be shipped at once.

During the site survey, the Survey Technician will follow the specific SOPs, and will record the data generated onto the Site Performance Survey Questionnaire forms. The historical data provided by the NADP PO will be verified. Within 24 hours, the Survey Technician will enter the data gathered into the FSSD. A backup of the data will be created after each site survey. Once three sites have been surveyed, the Survey Technician will send the original forms and database tables to EEMS.

At EEMS, the QA Manager will oversee receipt and log of the data package from the field. A technical assistant QA staff member will perform duplicate entry of numeric data from the forms completed by the Survey Technician. Backups of the data will be created after data from each site has been entered. The FSSD will then compare the two sets of data entered for the same site and will reveal any discrepancies. If any discrepancies are revealed, the QA Manager and the Project Manager will review the available records in order to reconcile the discrepancies. A backup of the data will be created once the data has gone through this QC process.

Within 15 days of the site survey, EEMS will forward the Site Performance Survey Report to the EPA Project Officer and the NADP QA Manager. The Site Performance Survey Report is comprised of the data entered in the Site Performance Survey Questionnaire forms after going through the QC process.

## 2.4 B4 – Analytical Methods

CAL will prepare simulated rain samples of known pH and specific conductance for use by EEMS in conducting surveys at AIRMoN sites. These samples will be prepared according to CAL's procedures and QAPP. These samples will be used by EEMS' Survey Technician to

evaluate the technique of the site operators and to determine the accuracy of the instruments in question.

## 2.5 B5 – Quality Control

EEMS is acutely aware that the NADP Site Survey Program is one QA/QC role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

EEMS QA Manager and Project Manager will review and oversee all of the procedures. Quality assurance documents (QMP and QAPP) will be prepared by the Project Manager with input and revisions by the QA Manager. These documents will specify the procedures followed as they relate to data collection and data entry.

Collected data will be recorded during the site surveys on the Site Performance Survey Questionnaire Forms. These handwritten entries will then be entered into the FSSD by the Survey Technician, and verified by means of appropriate built-in range checks for relevant fields.

Double data entry of the data collected will be performed by a technical assistant QA staff member. Any data discrepancies will be revealed by the FSSD. It will be the responsibility of the QA Manager and the Project Manager to resolve and reconcile any discrepancies between the two sets of data.

## 2.6 B6 – Equipment Testing, Inspection, and Maintenance

A list of the equipment and supplies used by EEMS in conducting the surveys is presented in each SOP. EEMS will inspect all equipment for damage prior to use and will operate and maintain the equipment in accordance with the manufacturer's instructions. EEMS QA Manager will be responsible for maintaining the Site Survey Kit and to oversee that the kit is complete and that required testing and maintenance is performed.

The purpose of the NADP Site Survey Program is the testing, inspection and maintenance of the equipment located at NADP sites. Table 6 below shows the type of maintenance to be performed by the Survey Technician while conducting the site surveys. Any testing, maintenance, and calibration will be performed in accordance with existing NADP SOPs and equipment manuals.

**Table 6. Maintenance Chart**

| NADP COLLECTOR | Calibrate | Troubleshoot | Clean | Adjust | Replace |
|---|---|---|---|---|---|
| Worn thrust collar | NA | Yes | No | Yes | No |
| Faulty sensor | NA | Yes | Yes | No | Yes |
| Poor bucket lid seal | NA | Yes | NA | Yes | Yes |
| Lid tension area | NA | Yes | Yes | Yes | No |
| Lid liner | NA | NA | No | NA | Yes |
| Faulty motor box | NA | Yes | NA | NA | Yes |
| Improper counter weight | NA | Yes | NA | Yes | Yes |
| Improperly mounted snow roof | NA | NA | NA | Yes | Yes |
| Missing or rusted mounting screws | NA | NA | Yes | NA | Yes |
| Missing chimney insulation (MDN) | NA | Yes | NA | Yes | Yes |
| Fuses | NA | Yes | NA | NA | Yes |
| **NADP RECORDING RAINGAGE** | **Calibrate** | **Troubleshoot** | **Clean** | **Adjust** | **Replace** |
| Faulty clock | No | Yes | No | No | Yes |
| Out of tolerance gage | Yes | Yes | Yes | Yes | No |
| Pen & event marker hang-up | NA | Yes | Yes | Yes | Yes |
| Low oil in damper | NA | Yes | No | NA | Yes |
| Pen traverse off time line | NA | Yes | Yes | Yes | No |
| Improper zero adjust | NA | Yes | Yes | Yes | No |
| Missing/loose screws | NA | Yes | No | Yes | Yes |
| **NWS STICK GAGE (AIRMoN)** | **Calibrate** | **Troubleshoot** | **Clean** | **Adjust** | **Replace** |
| Clean | NA | Yes | Yes | No | No |
| Level | Yes | Yes | No | Yes | NA |
| **FIELD LABORATORY (AIRMoN)** | **Calibrate** | **Troubleshoot** | **Clean** | **Adjust** | **Replace** |
| Poor pH measurement | Yes | Yes | Yes | Yes | No |
| Poor conductivity measurement | Yes | Yes | Yes | Yes | No |
| Poor mass measurement | Yes | Yes | Yes | Yes | No |

## 2.7 B7 – Instrument/Equipment Calibration and Frequency

Instruments and equipment located at the NADP sites will be calibrated according to the NADP Site Survey Program schedule. EEMS is responsible for surveying approximately 90 NADP sites per contract year, resulting in calibrations at each site once approximately every three years. EEMS will select the sites to be surveyed following these criteria:

- Select sites that have not been visited as part of this project for at least three years;
- Select sites in regional geographic proximity to one another;
- Select sites in the northern or mountainous parts of the networks to be visited during spring, summer and autumn months (to help facilitate travel and surveying operations).

Routine maintenance, calibration and certification of instruments and equipment used by EEMS while conducting site surveys will be the responsibility of the QA Manger. The QA Manger is also responsible for maintaining the appropriate certification and maintenance documentation and complying with the recertification schedule. Table 7 shows the equipment requiring regular maintenance and certification.

**Table 7. Equipment Certification Information**

| Item | Certifying Organization | Certification Frequency |
|---|---|---|
| Compass | Independent Laboratory | Annual |
| Electronic Balance | Independent Laboratory | Annual |
| Standard Weights | EEMS | Quarterly |
| Resistive Temperature Device (RTD) | Independent Laboratory | Semiannual |
| Multi meter | Independent Laboratory | Annual |
| Range finder | EEMS | Semiannual |

## 2.8 B8 – Inspection/Acceptance of Supplies and Consumables

Upon receipt of items and prior to use, EEMS QA Manager will perform an acceptance inspection in order to ensure conformance with the procurement requirements. The inspection may include verification of configuration or physical requirements, conformance with catalog descriptions, receipt of certifications, and no damage during shipping. The inspection will also include the calibration and/or setup of equipment and/or test of satisfactory performance. The QA Manager will document and maintain records of any relevant purchases, and any recertification schedule.

## 2.9 B9 – Non-direct Measurements

EEMS anticipates that the only non-direct measurements or data relevant to this project will be that provided by the NADP PO as historical data to be verified during the site survey. These historical data will be entered or imported into the FSSD and will become part of the Site Survey File. As the Survey Technician conducts the survey, this historical data will be verified, by either recording the corrected values in the Site Performance Survey Questionnaire forms, or accepting the historical values as correct.

## 2.10 B10 – Data Management

Data management activities will be performed according to the Systems and Performance SOPs developed for this project (see SOP-EPW07061-1010, SOP-EPW07061-1020 SOP-EPW07061-1030, and SOP-EPW07061-1500).

Among the preliminary survey activities EEMS will request from the NADP PO information pertaining to the sites scheduled to be surveyed. This type of information is presented in Table 8.

**Table 8. Preliminary Site Communication Information**

| Site Name | Site ID | Survey Date | Previous Survey Date | NADP Network(s) |
|---|---|---|---|---|
| Site #1 | | | | |
| Site #2 | | | | |
| Site #3 | | | | |
| : | | | | |

Information gathered from the NADP liaison during the preliminary communication should include the information presented in Table 9 for each site.

**Table 9. Initial Site Information**

| | Existing Information |
|---|---|
| Site operator (name, address, phone, e-mail) | |
| Site supervisor (name, address, phone, e-mail) | |
| Site sponsor contact (name, address, phone, e-mail) | |
| Precipitation gage (manufacturer, model) | |
| Precipitation collector (manufacturer, model) | |
| Balance (manufacturer, model) | |
| pH meter (manufacturer, model) | |
| Conductivity meter (manufacturer, model) | |

**Table 9. Initial Site Information (continued)**

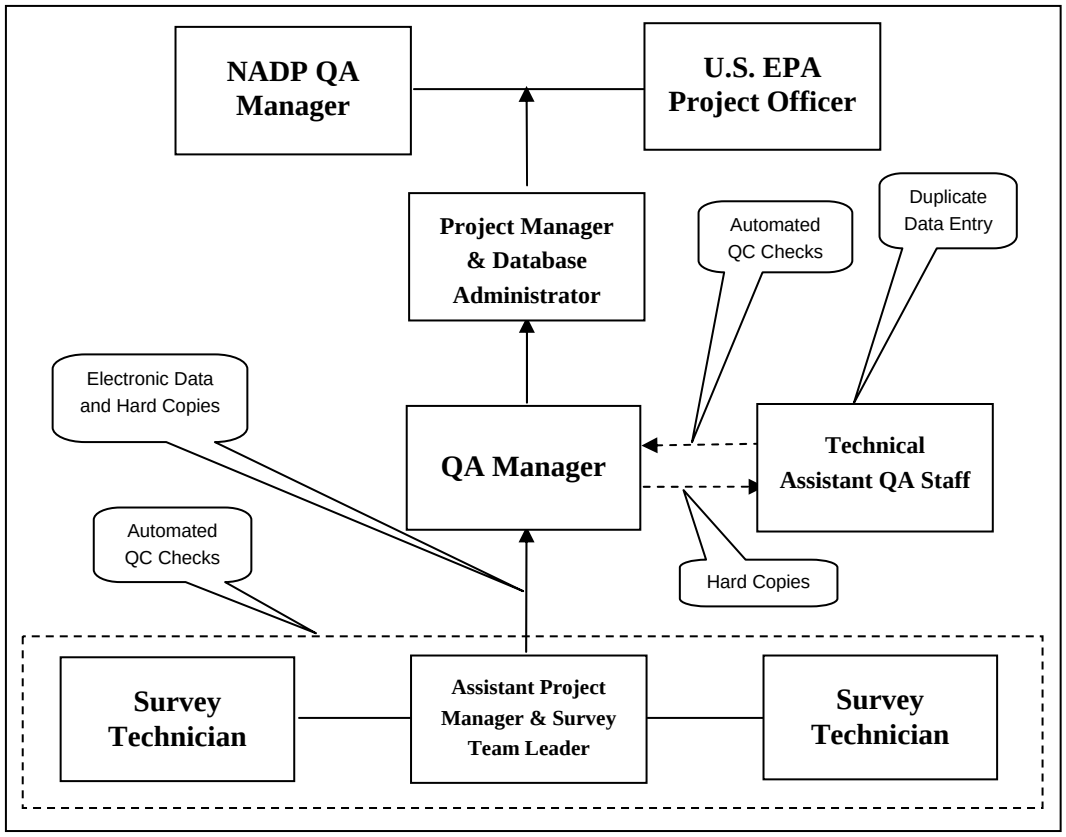
| | Existing Information |
|---|---|
| Site characteristics (i.e., solar power, remote, etc) | |
| Known problems (equipment and/or siting related) | |
| Additional requests (training issues, etc) | |
| Logistical concerns (i.e.,. passes or keys required, etc) | |
| Site sketch available and provided (pdf file name) | |

This information is entered into the FSSD and becomes part of the Site Survey File which is backed up any time new data is incorporated. The Site Survey File for each site will have a unique document control number. This Site Survey File will be included in the Site Survey Kit and will be shipped to the Survey Technician performing the survey.

As the Survey Technician conducts the site survey he or she will record all data gathered in the Site Performance Survey Questionnaire forms. These data will then be entered by the Survey Technician into the FSSD. The FSSD provides a QC check by providing the user with the appropriate ranges for the data being entered. After each site survey data set is entered the data tables will be backed up. Once three sites have been surveyed, the Survey Technician will send the files and forms to EEMS (in merchandise return envelopes).

At EEMS, the QA Manager will oversee receipt and log of the data package from the field, and the duplicate entry of numeric data from the forms into the FSSD. Backups of the data will be created after data from each site has been entered. The FSSD will then reveal any discrepancies, the QA Manager and the Project Manager will review the available records in order to reconcile any discrepancies. A backup of the data will be created once the data has gone through this QC process. The completed Site Performance Survey Questionnaire forms will become part of the Site Survey File together with any other reports generated by the FSSD. Figure 3 provides a schematic diagram of the data management.

**Figure 3. Schematic Diagram of Data Management**



# 3.0 GROUP C: Assessment and Oversight

The purpose of the NADP Site Survey Program is to ensure that good QA/QC practices are being applied as defined in the NADP Quality Management Plan (2003-01) and associated network quality assurance plans. The assessment of each NADP site is strictly controlled by the implementation of the NADP Site Survey Program QAPP.

## 3.1 C1 – Assessments and Response Actions

The NADP Site Survey Program is an external assessment program for the NADP. It is EEMS' goal to review 100% of the data generated during the period of this contract. In order to accomplish this goal, EEMS implements an internal assessment program along with an independent assessment program. The internal assessment begins with the review of SOPs, field forms, database and other data management tools by the Survey Technicians. Any concerns and/or suggestions are addressed by the QA Manager and the Project Manager. The QA Manager and the Project Manager are also responsible for database assessments. The QA Manager and Field Team Leader are responsible for assessments related to field techniques. In the event that the assessment program identifies problems with project data, as it pertains to data generation, data entry, data management or data reporting, response actions will be triggered. The nature of these actions will depend upon the severity and type of problem encountered, and will begin with a review of project procedures related to the identified problem.

### 3.1.1 C1.1 – Preventive Response Actions

These measures will be directed at preventing the identified problem from being repeated, and include the implementation of high-level monitoring of project activities associated with the problem to prevent further deviations; and initiation of a system of audits that will include random and unannounced evaluations of personnel and equipment to determine if procedures outlined in the QAPP are being followed. The project manager will be responsible for implementing corrective measures to address identified deviations from the QAPP.

### 3.1.2 C1.2 – Corrective Response Action

This measure will result in a correction of the problem and replacement of the problematic data with data that meet the project objectives. Corrective action will require re-entry of all questionable data into the FSSD.

### 3.1.3 C1.3 – Independent Assessments

Independent assessments are preformed by QA consultant, Dr. Peter Finkelstein who will perform an independent review of SOPs, QAPP, QMP, and annual reports. Other independent assessments

are performed by the NADP and subcommittees and EPA who review the SOPs, QAPP and annual reports.

After review and approval of the QAPP and SOPs and, if necessary, any training of Survey Technicians, the QA Manager will perform independent assessments of Survey Technicians. The goal of the assessments will be to evaluate the field techniques used by the Survey Technicians, and the applicability of the survey procedures.

Reports of the assessment will be included in the Annual Report. The reports will discuss the effectiveness of the survey technique and procedures in meeting the goals of the NADP and EPA.

## 3.2 C2 – Reports to Management

EEMS will produce monthly reports indicating progress and significant activities from the previous month as well as activities planned for the following month. This monthly report will be distributed to the EPA Project Officer and Contract Specialist.

Included as part the monthly reports there will be a summary of the latest deliverables to the appropriate organizations, a summary of any current project problems uncovered during the internal assessments mentioned above, or any deficiencies in meeting deliverable deadlines or quality assurance goals, and a list of outstanding actions awaiting EPA Project Officer authorization.

# 4.0 GROUP D: Data Validation and Usability Elements

This section addresses the QA activities that take place after data are collected during the site survey process.

## 4.1 D1 – Data Review, Verification, and Validation

It is EEMS' goal to review 100% of the data collected during site surveys. This is accomplished during the various stages of data entry and verification. It begins with the entry of field-collected data into the FSSD by the Survey Technician and the built-in database warnings when entered data is out of the expected range. This is followed by double entry of the same data into the FSSD by a different EEMS Technician, and the reconciliation of discrepancies encountered by the FSSD.

Maintaining current and valid certification of survey standards ensures that survey data are valid. Valid survey data in turn ensures that NADP data are valid. The QA Manager will report any certification results that would impact survey results if a standard was used for the survey that was found to be inaccurate. Any data qualifiers will be reported to EPA and other users.

## 4.2 D2 – Verification and Validation Methods

Data generated during the site surveys will be recorded by the Survey Technician on forms. Historical data will be verified or corrected during the survey. These data will then be entered into the FSSD which provides the user with warnings when data entered does not meet the criteria ascribed to a particular field. This will provide a second layer of verification. Field data will be entered a second time by another EEMS team member into the FSSD. The FSSD will then reveal any discrepancies between the two sets of data. These discrepancies will be reconciled by the QA Manager and the Project Manager by further scrutinizing the original field forms and if necessary, consulting with the Survey Technician or site operator.

Data validation methods for this project will consist of maintaining current any required certifications of standards used in the performance of the site surveys. Both data verification and validation methods will be used for data collected during site surveys. Some data collected will be observations made by the Survey Technician for which no instrumentation is required. Other data collected during the site survey may be measurements made by instruments, or responses from standards that require certification to a reference. All data will be verified, but only data collected by a measurement process will require validation.

All survey results will be range tested during the database entry process. All calculations of average errors, maximum errors, and linear regressions will be performed during the data collection process while completing the hardcopy field forms. The calculations will be repeated automatically as data entry in the database is completed for each form. The results of the calculations will then be compared thereby automatically checking the data entry. Discrepancies will be investigated and errors will be resolved.

This process will resolve errors prior to data being available to the users. If a survey standard is found to be in error the questionable data will be reported to the users when the error is discovered. Questionable survey data will be identified and corrective actions reported in the next report of results.

Results from the NADP Site Survey Program will be conveyed to the users by means of a number of deliverables. These consist of hardcopy reports (Spot Report, Site Performance Survey Report, Monthly and Annual Report) and electronic data tables to be imported by the NADP PO into their data management system.

The Spot Report will address the following items:

- Site, and site operator's information
- Immediate action items necessary to restore proper function to the site
- Any required site supplies or maintenance items
- Summary of survey activities

The Spot Report will be submitted as a hardcopy to the site supervisor and operator, NADP QA Manager and the EPA Project Officer at the completion of the site survey.

The Site Performance Survey Report will be generated by the FSSD once all the data entered for a site has undergone all the QA/QC stages. It is comprised of all the information gathered, and data recorded while conducting the survey and completing the Site Performance Survey Questionnaire forms. It covers all the areas covered during the survey: site information, siting criteria, all the instruments and equipment, site operator's assessment, and field laboratory. The Site Performance Survey Report will be submitted in electronic format within 15 days after completion of the site survey.

The Monthly Progress Report will be prepared for the EPA Project Officer indicating progress and significant activities from the previous month as well as activities planned for the following month.

The Annual Report will be a summary of the sites visited to include the overall status of the sites, problems encountered, and how these problems may be impacting the performance of the network. The report will provide information on the status of important performance measures, and will describe any significant events or changes to the networks that would affect interpretations of results, the quality of data produced by the program and any limitation in using the data.

## 4.3 D3 – Reconciliation with User Requirements

The survey program and results will be reviewed by the NADP PO and EPA Project Officer to identify changes or new requirements. The program documentation will be updated with any changes in program requirements. Survey results and network operation assessments will be discussed with users at management meetings. Recommendations for improvements to the program will be incorporated following periodic program review by EPA and data users.

# Appendix A.

# NADP Site Survey Program Standard Operating Procedures

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# Quality Assurance/Quality Control Documentation

| | |
|---|---|
| Title: | NTN Site Performance Survey Standard Operating Procedures (NADP INSTALLATIONS) |
| Document Number | SOP-EPW07061-1010 |
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## Authorizations

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**List of Acronyms and Abbreviations**

| | |
|---|---|
| CAL | Central Analytical Laboratory |
| CD | compact disc |
| DAS | data acquisition system |
| DCN | document control number |
| EDD | electronic data delivery |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FORF | Field Observer Report Form |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |

**List of Acronyms and Abbreviations (continued)**

| | |
|---|---|
| GPS | Global Positioning System |
| ISWS | Illinois State Water Survey |
| LOTO | lockout tag-out |
| NADP | National Atmospheric Deposition Program |
| NIST | National Institute of Standards and Technology |
| NTN | National Trends Network |
| PDA | Personal Digital Assistant |
| PO | Program Office |
| QAPP | quality assurance project plan |
| SOP | standard operating procedure |

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# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes an overview of the procedures for conducting performance surveys of National Atmospheric Deposition Program (NADP) National Trends Network (NTN) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. The NTN is one of the three networks of the NADP and is focused on long-term trends of precipitation chemistry and estimations of wet atmospheric deposition. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations. More specific instructions are provided in separate SOPs for each measurement system usually found at a NTN station. Those systems include precipitation gauges, precipitation collectors, and weighing devices (balance or scales). The individual SOPs are referenced in Section 5.0 Equipment and Supplies of this SOP.

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the NTN Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

NTN Site Performance Surveys include:

- Verifying that the site equipment and associated systems are capable of making valid and accurate measurements.
- Verifying that the precipitation collector is operating within the specifications of the NTN QAPP and capable of collecting valid samples.
- Challenging each measurement device (gauge, balance, or scale) with an independent audit standard [traceable to National Institute of Standards and Technology (NIST) or other authoritative standard] to determine if the device is operating within defined project accuracy goals provided in the NTN QAPP.
- Performing routine maintenance and/or minor repairs if necessary to return the site equipment to operation within the designated specifications.
- Subsequently re-challenging and/or retesting the equipment.
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD).
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD.

- Distributing the survey results, reports, and documentation to the designated project personnel.

## 1.1 Typical NTN Site Installations

The NTN Site Performance Survey program is intended to assess the operation of each site in the network. The network currently consists of approximately 250 sites throughout the United States, Puerto Rico, Mexico, and the Virgin Islands. The number and location of operational sites varies at any time. A list of active sites and locations can be found in the "Quality Assurance Project Plan (QAPP) – Support for Conducting Systems and Performance Surveys of National Atmospheric Monitoring Stations" (referred to from this point on as NADP Site Survey Program QAPP). An updated list may be available on the NADP website: http://nadp.sws.uiuc.edu/.

The program goal is to visit and survey approximately 90 total sites per year from the three individual networks, and each site in the NADP once approximately every three years. The current survey schedule can be found at ftp://67.192.214.230 in the NADP Final directory.

Specific equipment at each site can vary, but each site will consist of an approved precipitation gauge, an approved precipitation collector, a sample weighing device, equipment manuals, approved operating procedures, and site supplies. The approved NTN measurement and sampling equipment includes:

- Belfort 5-780 Mechanical Precipitation Gauge
- Aerochem Metrics (ACM type) Precipitation Collector
- ETI NOAH IV™ Electronic Precipitation Gauge
- OTT NADP Pluvio Electronic Precipitation Gauge
- Ohaus Mechanical Balance
- Various electronic scales

## 1.2 Preliminary Survey Activities

Due to the number and location of the sites in the network, the NTN site survey program is a travel intensive project. In order to maintain an efficient schedule and quality product, frequent and concise communication with project personnel is required. Prior to beginning travel, the U.S. Environmental Protection Agency (EPA) Project Officer, site liaisons at the NADP Program Office (PO), and the Central Analytical Laboratory (CAL), at the Illinois State Water Survey (ISWS) must be contacted. Their contact information is listed below:

- Michael Kolian 202-343-9261 kolian.michael@epa.gov EPA Project Officer

- Melissa Rury 202-343-9882 rury.melissa@epa.gov EPA Project Officer
- Mark Rhodes 217-244-6413 Rhodes1@illinois.edu NADP QA Manager
- Matt Layden 217-244-0372 ntn@sws.uiuc.edu CAL Liaison
- Roger Claybrooke 217-244-2838 dclay@sws.uiuc.edu NADP PO

In order to adhere to the schedule set forth in the NADP Site Survey Program QAPP, the above listed personnel must be contacted no less than one month prior to the planned date of the site survey. The initial communication must include the information contained in Table 1 for each planned site survey.

**Table 1. Preliminary Site Communication Information**

| Site Name | Site ID | Survey Date | Previous Survey Date | NADP Network(s) |
|---|---|---|---|---|
| Site #1 | | | | NTN |
| Site #2 | | | | |
| Site #3 | | | | |
| : | | | | |

Information obtained from the NADP liaisons during the preliminary communication should include the information contained in Table 2 below for each site.

**Table 2. Initial Site Information**

| | Existing Information |
|---|---|
| Site operator (name, address, phone, e-mail) | |
| Site supervisor (name, address, phone, e-mail) | |
| Site sponsor contact (name, address, phone, e-mail) | |
| Precipitation gauge (manufacturer, model) | |
| Collector (manufacturer, model) | |
| Balance (manufacturer, model) | |
| Site characteristics (i.e., solar power, remote, etc) | |
| Known problems (equipment and/or siting related) | |
| Additional requests (training issues, etc) | |
| Logistical concerns (i.e., passes or keys required, etc) | |
| Site sketch available and provided (pdf file name) | |

Figure 1 is an example of the initial site information for site WA14 as received from the NADP PO.

**Figure 1. NADP Pre-Audit Site Information NTN Site WA14**

**National Atmospheric Deposition Program**
**Pre-Audit Site Information**
**NTN Site WA14**

| | | | |
|---|---|---|---|
| Site ID | WA14 | Site Name | Olympic National Park-Hoh Ranger Station |
| Latitude | 47.86 | County | Jefferson |
| Longitude | -123.9319 | Sponsoring Agency | NPS-ARD |
| Elevation | 176 | Operating Agency | NPS-Olympic NP |
| Start | 5/20/1980 | Site Owner | NPS |
| Stop | | Map | Owl Mountain |
| Status | A | | |

**Installed Equipment**

| Wet/Dry Sampler | | Primary Rainguage | | Field Lab | |
|---|---|---|---|---|---|
| Type | ACM | Type | Belfort 5-780 | Scale | Ohaus 1119D |
| Power | AC | Shield | None | pH Meter | Beckman phi 32 |
| Heated | N | Distance to WD | 5.5 | pH Electrode | Broadley-James BNC |
| Lid | F | **Backup Rainguage** | | Cond. Meter | YSI 35 |
| Event Recorder | S | Type | 8 in cylinder | Cond. Cell | YSI 3403 |
| | | Distance to WD | 1.2 | | |

| | Supervisor | Operator |
|---|---|---|
| Name | Bill Baccus | Bill Baccus |
| Phone | 360-565-3061 | 360-565-3061 |
| Alt Phon | | |
| Fax | 360-374-2676 | 360-374-2676 |
| Email | bill_baccus@nps.gov | bill_baccus@nps.gov |
| Training | | |
| | Bill Baccus<br>Olympic National Park<br>600 East Park Avenue<br>Port Angeles, WA 98362-6798 | Bill Baccus<br>Olympic National Park<br>600 East Park Avenue<br>Port Angeles, WA 98362-6798 |

**Funding Agency Representative**

| | | |
|---|---|---|
| Name | Kristi Morris | Kristi Morris<br>National Park Service<br>Air Resources Division<br>12795 W. Alameda Parkway<br>Lakewood, CO 80228 |
| Phone | 303-987-6941 | |
| Alt Phon | | |
| Fax | 303-969-2822 | |
| Email | kristi_morris@nps.gov | |

After obtaining the site contact information from the site liaisons, the site operators and supervisors for each site in the planned trip must be contacted by telephone at least two weeks

prior to the planned site visit. If the planned survey will be the first survey for a particular site (i.e., Previous Survey Date = null), the site sponsor for that site will also be contacted by phone and notified of the survey.
Discussions with the site personnel will include logistics pertaining to accessing the site, date and time of the planned site survey, any modifications that may have been performed on the site instrumentation, and any operational problems that may exist at the site. All relevant information will be added to the data gathered during the preliminary communication with the site liaisons.

Once the initial communication with the site liaisons and site operators has occurred, the comprehensive information obtained for each site will be compiled and included in a Site Survey File.

### 1.2.1 Preliminary Site Survey File

During these preliminary survey activities, the Site Survey File will contain the compiled comprehensive information obtained during the preliminary communication and data gathering process described above. The information for each site will include records of phone calls, e-mail correspondence, and completed site information data tables.

The file will become a permanent historical record of site survey information and documentation. It will be assigned a Document Control Number (DCN) and will become part of the site survey data management system. Appropriate site information obtained thus far will be entered (or imported) into the FSSD. Initial site data forms will then be generated and included in the Site Survey File and copied and included in the Site Survey Kit to be provided to the Survey Technician responsible for conducting the site survey.

### 1.2.2 Site Survey Kit

At this step in the performance survey procedures, a Site Survey Kit will be prepared at EEMS. The Site Survey Kit will be assembled utilizing the preliminary information gathered for each site. The site-specific tools, equipment, maintenance items, forms, certification records, Personal Digital Assistant (PDA), field computer with FSSD, and survey supplies required to perform the survey of each site in the planned trip will be inventoried and packed for shipment.

Arrangements will be made with the Survey Technician for the shipment of the kit to the field. Upon receipt of the Site Survey Kit, the Survey Technician will inspect the kit and report any damage or missing articles. After completing any additional shipments that may be necessary, the Site Survey Kit inventory and shipping log will be included in the Site Survey File.

The EEMS QA Manager will oversee the process of completing the preliminary Site Survey File, and providing the Survey Technician with the required materials to complete the planned surveys.

Once receipt of the complete and functional survey kit is confirmed by the Survey Technician, the preliminary Site Survey File is complete. Post-survey information will be included following the site visit and survey by the Survey Technician.

# 2.0 Summary of Methods

General methods used for performing a NTN Site Performance Survey will include the completion of the preliminary survey activities described in the previous sections and then:

- Traveling to the site and challenging or testing each measurement and collection device according to the SOP for that device,
- Recoding the observed and collected data on the appropriate form,
- Performing any routine maintenance, adjustment, or minor repair,
- Repeating the challenge or test of the device,
- Recording the results of the additional challenge or test,
- Entering the recorded data into the FSSD and backing up the files,
- Generating the exit report (Spot Report) of the survey activities from the FSSD within 24 hours of completing the survey,
- Transferring the hardcopy recorded data and the electronic FSSD files to the EEMS data management facility,
- Verbally reporting the results of the survey to the site liaison with any requests for additional attention or activities to be performed at the site within 24 hours of completing the survey.

The specific methods used to complete a challenge or test of the measurement and collection equipment and instrumentation at each site are unique for the type of equipment and the instrumentation present at the particular NTN site. Specific SOPs have been developed for that purpose.

## 2.1 Instrument Specific Methods

The list of approved NTN site equipment and instrumentation is presented in Section 1.1. The preliminary survey activities identify which of the listed types of instrumentation are present at each site. Table 3 identifies the specific SOP for the equipment or instrumentation type.

**Table 3. Instrument Specific Methods**

| SOP Name | SOP Number | Revision Number | Revision Date |
|---|---|---|---|
| Belfort 5-780 Precipitation Gauge | SOP-EPW07061-1400 | 1 | May 2008 |
| OTT NADP Pluvio Precipitation Gauge | SOP-EPW07061-1410 | 1 | May 2008 |

| | | | |
|---|---|---|---|
| ETI NOAH IV™ Precipitation Gauge | SOP-EPW07061-1420 | 1 | May 2008 |
| ACM NTN Precipitation Collector | SOP-EPW07061-1310 | 1 | May 2008 |
| Ohaus Mechanical Balance | SOP-EPW07061-1210 | 1 | May 2008 |

Using this SOP and those presented in Table 3, any currently operating NTN site can be surveyed. As new equipment or instrumentation is approved for use at NTN sites, new methods and procedures will be developed to challenge and test that equipment and instrumentation. Those methods will be incorporated into this SOP and Table 3.

# 3.0 Health and Safety Warnings

The NADP Site Survey Program and NTN Site Performance Survey requires travel to various locations and assessing the condition and operation of electrical devices. As such there are some health and safety warnings and cautions that must be observed.

## 3.1 Electrical

The sample collection devices, and some of the precipitation gauges, are powered by 120 volt AC power. This is the typical household electrical service which powers most common appliances. The same cautions practiced for any device powered by this means should be observed for the site equipment.

In some cases the power may be delivered using extension cords or buried electrical wires. Particular attention should be paid to the manner and condition of the power supply and distribution. No digging or under-ground probing should be conducted without first identifying all buried services.

Prior to removing any instrument electrical service covers or fuses, disconnect the power source to the instrument. This can be accomplished by unplugging the power cord or tuning off the circuit breaker and employing a proper “lockout tag-out” (LOTO) procedure.

### 3.1.1 Lockout Tag-out

LOTO procedures are intended to protect survey personnel and technicians from electrical hazards while troubleshooting and servicing electrical equipment. If the power supply to the device is not in the direct control of the technician, LOTO procedures must be used to ensure that the power is not supplied to the device during the activities. This is accomplished by locating the source of the power (electrical outlet or circuit distribution panel) and disconnecting the power source. Unplugging the cord or turning the circuit breaker off will then disconnect the power. In

rare instances it may be necessary to disconnect the main power supply or main breaker that supplies power to all of the circuits in the distribution panel.

After the power supply has been disconnected access to the panel or outlet must be locked and tagged with a notice for other personnel that service is being conducted on a component of that circuit. This is intended to prevent the circuit from being activated by other personnel that may enter the area and not realize that a technician is working on a device on that circuit.

### 3.2 Remote Locations

Some of the stations in the NTN are located in remote areas. Access to the site may be limited to hiking trails. The trails may be mountainous, or rugged and steep, and at high elevations. Shelter may not be available at the site location. Caution and care should be exercised to prevent overexertion when accessing these sites. Protective clothing and boots should be worn, and adequate fluids should be available for the duration of the site visit.

### 3.3 Travel and Driving

By far the most dangerous activity undertaken during the site survey program is travel by driving to the site locations. All safety regulations recommended for the operation of motor vehicles must be observed. This includes the use of seatbelts and shoulder restraints.

All operators must have a valid operator's license and the insurance required by both the issuing agency and the contract (or subcontract) clauses.

The consumption of alcohol or other drugs that may cause impairment are not permitted prior to or while operating a motor vehicle.

Extended travel and long working hours can cause stress and fatigue. These conditions can adversely affect ones ability to operate a motor vehicle. Personnel must be aware of stress and fatigue levels and not operate a motor vehicle under these conditions. Personnel are urged to get the necessary rest required to stay alert while driving.

## 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the

installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the NTN. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

### 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

## 5.0 Equipment and Supplies

Together with this SOP, the individual instrument SOPs listed here are required for conducting performance surveys at NTN designated NADP precipitation collection stations. They are intended to be used by qualified technicians that understand general instrument operation and survey techniques. The following SOPs provide technical guidance and detailed information regarding specific NADP NTN site survey procedures:

- SOP-EPW07061-1400 – ***Belfort Precipitation Gauge Standard Operating Procedures, (NADP Installations)***
- SOP-EPW07061-1410 – ***OTT NADP Pluvio Electronic Gauge Standard Operating Procedures, (NADP Installations)***
- SOP-EPW07061-1420 – ***ETI NOAH IV™ Electronic Precipitation Gauge Standard Operating Procedures (NADP Installations)***
- SOP-EPW07061-1310 – ***ACM NTN Precipitation Collector Standard Operating Procedures (NADP Installations)***
- SOP-EPW07061-1210 – ***Ohaus Mechanical Balance Standard Operating Procedures (NADP Installations)***
- SOP-EPW07061-1210 – ***Various Electronic Scales Standard Operating Procedures (NADP Installations)***

### 5.1 Survey Tools and Materials

In addition to the specific instruments and equipment listed in the individual SOPs, the following materials are required to perform NADP NTN site surveys:

- NADP NTN QAPP
- Site Survey File for each site in the planned trip
- Hardcopy data forms (forms provided in each Site Survey File)
- Laptop computer with approved FSSD
- Global Positioning System (GPS)
- Miscellaneous recordkeeping supplies
- Manufacturer's instruction manuals

# 6.0 Instrument or Method Calibration and Standardization

Each method used to challenge or test a measurement or collection device deployed at NADP NTN site will be referenced to a carefully calibrated and certified standard. The rational and development of those procedures is discussed below.

## 6.1 Standard Weights

The majority of challenges performed on measurement systems at NTN sites will be the use of a standard weight to simulate precipitation and then comparing the instrument response to the equivalent precipitation that corresponds to the standard weight. The equivalent precipitation amount is a function of the size of the opening in the particular precipitation gauge and the calibration of the gauge itself.

In order to accurately determine the equivalent precipitation amount, an accurate measurement of each standard weight must be performed. This will be accomplished at the EEMS facility with a precision electronic balance. The balance will be certified annually by an independent organization using standard reference methods and materials. EEMS will check the calibration of the balance prior to each use with transfer weights that are certified at the time of the balance certification. The balance calibration weights will be maintained at the EEMS facility in a manner that protects their condition and weight.

### 6.1.1 Instrument Sensitivity to Weight/Mass

The various precipitation gauges approved for NTN respond differently to the weight applied to the catch basin. For example the Belfort gauges respond with an equivalent precipitation amount of approximately one inch when a weight of approximately 825 grams is added to the bucket. This will be the smallest standard weight used for the Belfort gauges, and measured to the hundredth of one inch. The electronic ETI and OTT NADP Pluvio gauges are more sensitive and

will be challenged with much smaller weights that correspond to precipitation amounts of 0.25 and 0.50 inches.

All weights will be checked and their weight documented at EEMS during the preparation of the Site Survey Kit. Using the precisely measured weight the corresponding equivalent precipitation amount will be calculated for the intended gauge and included with the kit. The weights will be properly packed and handled in order to preserve their condition during the site survey trips.

### 6.2 Temperature Checks

Precipitation collector operation is triggered by a sensor that detects the presence of precipitation. The sensor is heated to evaporate the precipitation following an event so the collector does not remain open exposing the sample.

The temperature of the sensor will be measured by a transfer temperature probe that is calibrated and referenced to a standard. This will be performed annually and the results documented in each Site Survey Kit, and in each Site Survey File.

### 6.3 Voltage Checks

The NTN Site Performance Surveys will include various voltage checks of the instruments and equipment. Those checks will be performed using a certified multimeter. The multimeter will be certified annually by an independent organization. Certification documentation will be included with each Site Survey Kit, and each Site Survey File.

## 7.0 Troubleshooting

One function of the NADP Site Survey Program is the routine maintenance and minor repair of the site equipment to continue or restore the operation to the NADP specifications. In order to perform this function some troubleshooting of malfunctioning equipment or instrumentation may be necessary. The instructions provided to site operators by the NADP PO and the manuals provided by the instrument manufacturers will be utilized to perform the troubleshooting procedures. The experience of the site Survey Technician will ensure exceptional troubleshooting techniques.

The list of items that are routinely addressed during a NTN Site Performance Survey is included in Table 6 of the NADP Site Survey Program QAPP.

### 7.1 Site Survey Instrument Function

The tools, instruments, standards, and materials that make up each Site Survey Kit are carefully controlled, tested, calibrated and maintained by the EEMS QA staff. This process is intended to ensure proper and accurate function when the kit is used in the field. Should any of the items malfunction during a site survey trip, troubleshooting will be performed in the same manner by the site survey team with the assistance of the EEMS QA Manager.

If any field repairs are performed on items in the survey kit, the EEMS QA Manager will determine if the certification of that item and survey results measured by that item are compromised. If necessary a replacement item will be sent to the Survey Technician to ensure accurate survey results.

## 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition at most of the NTN sites is accomplished by visual observations, made by site operators, and site instrument measurements on hardcopy media (rain gauge charts). These are manually recorded to hardcopy forms by the site operator and then sent to the CAL. As electronic precipitation gauges are deployed at NTN sites data acquisition will be accomplished by radio transmission to handheld data devices and then electronically sent to the CAL. Some sites will also employ direct telemetry from the site equipment to the CAL.

Data acquisition for systems surveys of NADP sites will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections.

### 8.1 Post-Site Survey Procedures

At this point the information gathered during the site survey will be recorded on the data forms associated with data collection for each measurement process or system. The data forms comprise the complete Site Survey Questionnaire which is included in Appendix B.

The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the EPA, the NADP PO, and other data users. The method and tasks to be completed after recording survey data are described in the following sections.

### 8.1.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

#### 8.1.1.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 2 shows this first screen.

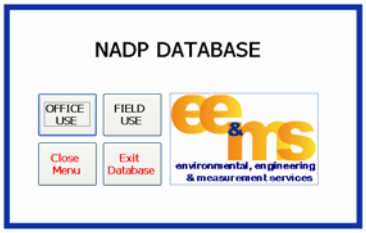



**Figure 2. User Type Selection Menu**

#### 8.1.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

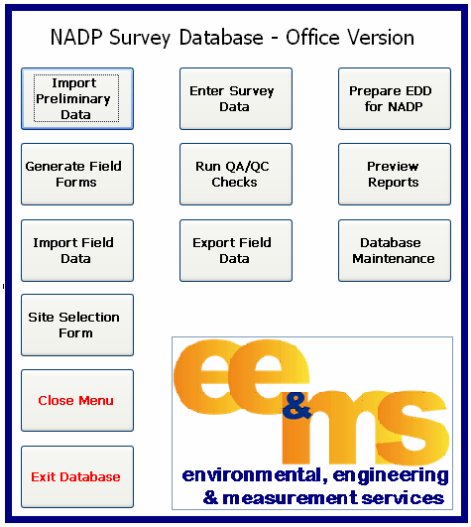



**Figure 3. NADP Survey Database – Office Version Main Menu**

#### 8.1.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 4 shows the different options the user can choose form:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

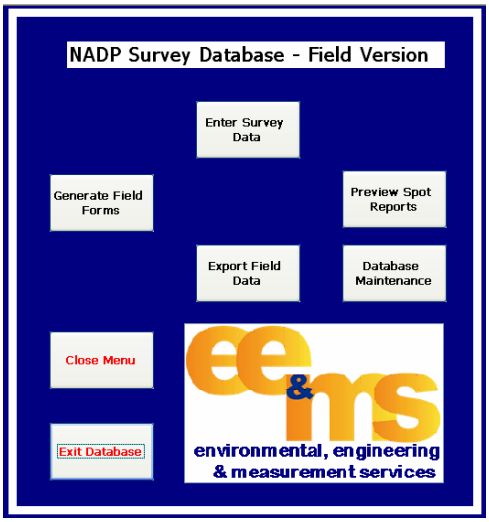



**Figure 4. NADP Survey Database – Field Version Main Menu**

#### 8.1.1.4 Enter Survey Data

The Enter Survey Data menu (Figure 5) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

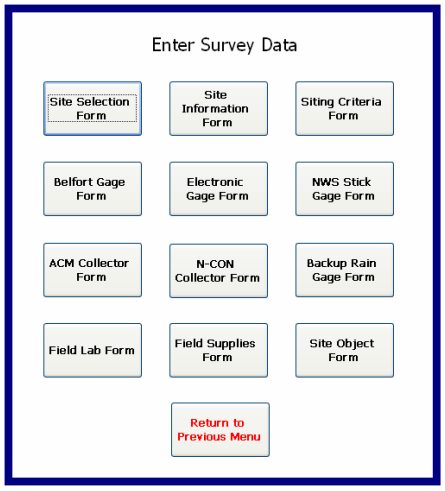



**Figure 5. Enter Survey Data Menu**

#### 8.1.1.5 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 6 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most

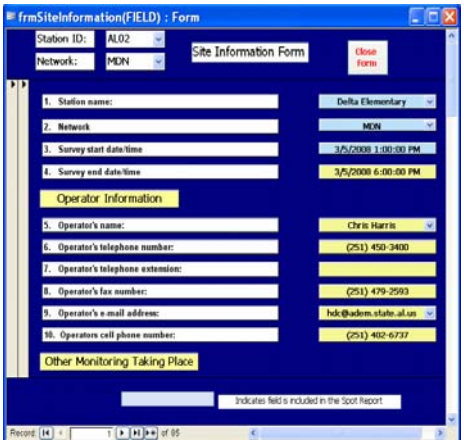



**Figure 6. Site Information Form (Field Form)**

appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

#### 8.1.1.6 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 7):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

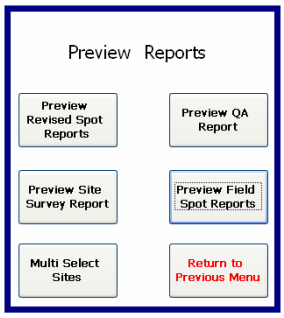



**Figure 7. Preview Reports Menu**

## 8.2 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.3 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.4 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

### 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

## 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data at the NTN sites. Some sites utilize handheld data devices as previously described, and their use is anticipated to increase as more electronic gauges are installed.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

### 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

### 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.0 and subsections.

After data entry the required Spot Report can be generated and distributed. This will contain the maintenance items required (if any) at the site. The electronic data tables will also be generated and exported to the duplicate database at EEMS.

### 9.2.1 Field Data Backup

Each Site Survey Kit will contain a "thumb drive" (or flash) memory device capable of storing all the data tables containing the survey data, and digital photos acquired during the site survey trip. After entering the survey data for each site, all data will be copied to the thumb drive for backup. This procedure will continue for each site in the survey trip. At the conclusion of the trip, the thumb drive will be sent with the final hardcopy data forms from the last site visited, separately from the field computer which at this point will also contain a copy of the same information. Prior to the field computer and Site Survey Kit being sent back to EEMS, two copies of the site survey data tables and all other information (digital photos, electronic reports, etc) will be written to compact disc (CD). One disc will be included with the Site Survey Kit and returned to EEMS, and one disc will be kept by the Survey Technician for his or her records.

# 10.0 Data Management and Records Management

Most of the data and records management procedures have been discussed throughout the previous sections. Particularly the preliminary Site Survey File data gathering process and the field site survey data gathering and management processes. This section and subsequent subsections describes the management of the final site survey data and Site Survey File at EEMS.

## 10.1 Shipping and Tracking

As mentioned in Subsection 1.2.2, prior to conducting site visits, the Site Survey File will contain all the preliminary information gathered, and the record of shipment and receipt of the Site Survey Kit. As information is received at EEMS following site visits, it is logged and that record is added to the Site Survey File.

The QA Manager will oversee the process of receiving the electronic data export from the field and the importation of that data into the duplicate database at EEMS. After the original hardcopy data forms have been received and logged the duplicate data entry process will begin.

## 10.2 Duplicate Data Entry and Reconciliation

As a QC check, duplicate data entry will be performed for designated site survey data fields, most of which will be numeric data results. The intention of duplicate data entry is to minimize typographical errors. Theoretically it is unlikely for two different people to make the same mistake when entering the same data. Therefore by comparing both entries the mistakes made during each entry will be identified. The duplicate entry will be performed at EEMS by personnel other than the site Survey Technician. The entry will be overseen by the QA Manager.

Following the duplicate data entry process the data tables will be automatically compared for differences. Any difference will automatically be flagged for further investigation. The QA Manager will be responsible for reconciling any differences by reference to the original hardcopy data form or discussion with the Survey Technician or site operator.

A record of the differences found and the resolution of the differences will be added to the Site Survey File and included in the monthly progress and management reports. If for any reason a difference cannot be resolved, it will be identified for further action and all actions will be reported in monthly progress reports.

## 10.3 Final Data Set

After the QA manager has ensured that all of the steps described above have been performed and approved the site survey data tables, the site survey data is considered final. At this stage in the management process following entry of each and every site survey data set, the database is backed up to an external hard drive on-site and off-site.

### 10.3.1 Site Survey Performance Report

From the final data set a Site Survey Performance Report is generated and distributed for each site survey. This report will address any differences that may have been reported in the Spot Report. The Project Manager will be responsible for generating and distributing this report. The electronic Site Survey Performance Reports will be delivered within 15 days from the site survey. Other hardcopy information such as edited site sketches will be mailed to the NADP PO. Copies of all information will be retained and added to the Site Survey File.

Following delivery of the Site Survey Performance Report and any hardcopy information, the Site Survey File for the completed site will be closed and archived. The DCN will indicate the Site ID, Network ID, and the date of the survey to allow for retrieval if requested. A new Site Survey File will be initiated at least one month prior to the next scheduled site survey.

### 10.3.2 Electronic Data Delivery

Electronic data delivery (EDD) files will be delivered with the monthly progress reports for those months when site surveys were conducted. The format of the EDD will be developed with the assistance of the NADP PO and suitable for import into the NADP database. The electronic data files will contain all of the information included in the Site Survey Performance Report. The EDD files will also contain all other digital information collected during the site survey such as digital photographs.

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one QA/QC role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for NTN Site Performance Survey procedures, but for all projects at EEMS

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This began with the review of the documentation as described and the incorporation of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

### 11.2.1 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

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# Quality Assurance/Quality Control Documentation

| | |
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## Authorizations

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| QA Manager | Keith Halbrook | EEMS | Charles Keith Hallbrook |
| EPA Project Officer | | | |

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**List of Acronyms and Abbreviations**

| | |
|---|---|
| CD | compact disc |
| DAS | data acquisition system |
| DCN | document control number |

**List of Acronyms and Abbreviations (continued)**

| | |
|---|---|
| EDD | electronic data delivery |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| GPS | Global Positioning System |
| ISWS | Illinois State Water Survey |
| HAL | Mercury Analytical Laboratory |
| Hg | mercury |
| LOTO | “lock out” “tag-out” |
| MDN | Mercury Deposition Network |
| MOF | MDN Observer Form |
| NADP | National Atmospheric Deposition Program |
| NIST | National Institute of Standards and Technology |
| PDA | Personal Digital Assistant |
| PO | Program Office |
| QAPP | quality assurance project plan |
| SOP | standard operating procedure |

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# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes an overview of the procedures for conducting performance surveys of National Atmospheric Deposition Program (NADP) Mercury Deposition Network (MDN) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. The MDN is one of the three networks of the NADP and is focused on long-term trends of mercury concentrations in precipitation and estimations of wet atmospheric deposition. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations. More specific instructions are provided in separate SOPs for each measurement system usually found at a MDN station. Those systems include precipitation gauges and precipitation collectors. The individual SOPs are referenced in Section 5.0 Equipment and Supplies of this SOP.

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the MDN Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

MDN Site Performance Surveys include:

- Verifying that the site equipment and associated systems are capable of making valid and accurate measurements.
- Verifying that the precipitation collector is operating within the specifications of the MDN QAPP and capable of collecting valid samples.
- Challenging precipitation gauge with an independent audit standard [traceable to National Institute of Standards and Technology (NIST) or other authoritative standard] to determine if the device is operating within defined project accuracy goals provided in the MDN QAPP.
- Performing routine maintenance and/or minor repairs if necessary to return the site equipment to operation within the designated specifications.
- Subsequently re-challenging and/or retesting the equipment.
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD).
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD.

- Distributing the survey results, reports, and documentation to the designated project personnel.

## 1.1 Typical MDN Site Installations

The MDN Site Performance Survey program is intended to assess the operation of each site in the network. The network currently consists of approximately 100 sites throughout the United States, Canada, and Mexico. The number and location of operational sites varies at any time. A list of active sites and locations can be found in the "Quality Assurance Project Plan (QAPP) – Support for Conducting Systems and Performance Surveys of National Atmospheric Monitoring Stations" (referred to from this point on as NADP Site Survey Program QAPP). An updated list may be available on the NADP website: http://nadp.sws.uiuc.edu/.

The program goal is to visit and survey approximately 90 sites per year from the three individual networks, and each site in the NADP once approximately every three years. The current survey schedule can be found at ftp://67.192.214.230 in the NADP Final directory.

Specific equipment at each site can vary, but each site will consist of an approved precipitation gauge, an approved precipitation collector, equipment manuals, approved operating procedures, and site supplies. The approved MDN measurement and sampling equipment includes:

- Belfort 5-780 Mechanical Precipitation Gauge
- Aerochem Metrics (ACM type) Precipitation Collector
- ETI NOAH IV™ Electronic Precipitation Gauge
- OTT NADP Pluvio Electronic Precipitation Gauge
- N-CON MDN Precipitation Collector

## 1.2 Preliminary Survey Activities

Due to the number and location of the sites in the network, the MDN site survey program is a travel intensive project. In order to maintain an efficient schedule and quality product, frequent and concise communication with project personnel is required. Prior to beginning travel, the U.S. Environmental Protection Agency (EPA) Project Officer and site liaison at the NADP Program Office (PO) at Illinois State Water Survey (ISWS), and the site liaison at the Mercury (Hg) Analytical Laboratory (HAL) at Frontier Geosciences, must be contacted. Their contact information is listed below:

| | | | |
|---|---|---|---|
| Michael Kolian | 202-343-9261 | kolian.michael@epa.gov | EPA Project Officer |
| Melissa Rury | 202-343-9882 | rury.melissa@epa.gov | EPA Project Officer |
| Mark Rhodes | 217-244-6413 | Rhodes1@illinois.edu | NADP QA Manager |

| | | | |
|---|---|---|---|
| Doug Disney | 206-622-6960 | dougd@frontiergeosciences.com | HAL Liaison |
| Gerard van der Jagt | 206-622-6960 | gerardj@frontiergeosciences.com | HAL Liaison |

In order to adhere to the schedule set forth in the NADP Site Survey Program QAPP, the above listed personnel must be contacted no less than one month prior to the planned date of the site survey. The initial communication must include the information contained in Table 1 for each planned site survey.

**Table 1. Preliminary Site Communication Information**

| Site Name | Site ID | Survey Date | Previous Survey Date | NADP Network(s) |
|---|---|---|---|---|
| Site #1 | | | | MDN |
| Site #2 | | | | |
| Site #3 | | | | |
| : | | | | |

Information obtained from the NADP liaisons during the preliminary communication should include the information contained in Table 2 below for each site.

**Table 2. Initial Site Information**

| | Existing Information |
|---|---|
| Site operator (name, address, phone, e-mail) | |
| Site supervisor (name, address, phone, e-mail) | |
| Site sponsor contact (name, address, phone, e-mail) | |
| Precipitation gauge (manufacturer, model) | |
| Collector (manufacturer, model) | |
| Site characteristics (ie. solar power, remote, etc) | |
| Known problems (equipment and/or siting related) | |
| Additional requests (training issues, etc) | |
| Logistical concerns (ie. passes or keys required, etc) | |
| Site sketch available and provided (pdf file name) | |

Figure 1 is an example of the initial site information for MDN site AL03 as received from the NADP PO.

**Figure 1. NADP Pre-Audit Site Information MDN Site AL03**

**National Atmospheric Deposition Program**
**Pre-Audit Site Information**
**MDN Site AL03**

| | | | |
|---|---|---|---|
| Site ID | AL03 | Site Name | Centreville |
| Latitude | 32.9035 | County | Bibb |
| Longitude | -87.2499 | Sponsoring Agency | Southern Company/Atmospheric Research & Analysi |
| Elevation | 135 | Operating Agency | Atmospheric Research |
| Start | 6/20/2000 | Site Owner | |
| Stop | | Map | USGS 1:24000 |
| Status | A | | |

**Installed Equipment**

| | **Supervisor** | **Operator** |
|---|---|---|
| Name | David Lowery | Dennis Stripling |
| Phone | 205-585-8433 | 205-926-7537 (H) |
| Alt Phon | | 205-393-3907 (Cell) 205-926-6325 (site) |
| Fax | 205-426-6325 | 205-926-6365 |
| Email | dlowery@atmospheri-research.com | ctr@atmospheric-research.com |
| Training | | |

Dennis Stripling
323 Tabernacle Road
Brent, AL 35034-3714

After obtaining the site contact information from the site liaisons, the site operators and supervisors for each site in the planned trip must be contacted by telephone at least two weeks prior to the planned site visit. If the planned survey will be the first survey for a particular site

(i.e., Previous Survey Date = null), the site sponsor for that site will also be contacted by phone and notified of the survey.

Discussions with the site personnel will include logistics pertaining to accessing the site, date and time of the planned site survey, any modifications that may have been performed on the site instrumentation, and any operational problems that may exist at the site. All relevant information will be added to the data gathered during the preliminary communication with the site liaisons.

Once the initial communication with the site liaisons and site operator has occurred, the comprehensive information obtained for each site will be compiled and included in a Site Survey File.

### 1.2.1 Preliminary Site Survey File

At this point, during the preliminary survey activities, the Site Survey File will contain the compiled comprehensive information obtained during the preliminary communication and data gathering process described above. The information for each site will include records of phone calls, e-mail correspondence, and completed site information data tables.

The file will become a permanent historical record of site survey information and documentation. It will be assigned a Document Control Number (DCN) and will become part of the site survey data management system. Appropriate site information obtained thus far will be entered (or imported) into the FSSD. Initial site data forms will then be generated and included in the Site Survey File and copied and included in the Site Survey Kit to be provided to the Survey Technician responsible for conducting the site survey.

### 1.2.2 Site Survey Kit

At this step in the performance survey procedures, a Site Survey Kit will be prepared at EEMS. The Site Survey Kit will be assembled utilizing the preliminary information gathered for each site. The site-specific tools, equipment, maintenance items, forms, certification records, Personal Digital Assistant (PDA), field computer with FSSD, and survey supplies required to perform the survey of each site in the planned trip will be inventoried and packed for shipment.

Arrangements will be made with the Survey Technician for the shipment of the kit to the field. Upon receipt of the Site Survey Kit, the Survey Technician will inspect the kit and report any damage or missing articles. After completing any additional shipments that may be necessary, the Site Survey Kit inventory and shipping log will be included in the Site Survey File.

The EEMS QA Manager will oversee the process of completing the preliminary Site Survey File, and providing the Survey Technician with the required materials to complete the planned surveys.

Once receipt of the complete and functional survey kit is confirmed by the Survey Technician, the preliminary Site Survey File is complete. Post-survey information will be included following the site visit and survey by the Survey Technician.

# 2.0 Summary of Methods

General methods used for performing a MDN Site Performance Survey will include the completion of the preliminary survey activities described in the previous sections and then:

- Traveling to the site and challenging or testing each measurement and collection device according to the SOP for that device,
- Recoding the observed and collected data on the appropriate form,
- Performing any routine maintenance, adjustment, or minor repair,
- Repeating the challenge or test of the device,
- Recording the results of the additional challenge or test,
- Entering the recorded data into the FSSD and backing up the files,
- Generating the exit report (Spot Report) of the survey activities from the FSSD within 24 hours of completing the survey,
- Transferring the hardcopy recorded data and the electronic FSSD files to the EEMS data management facility,
- Verbally reporting the results of the survey to the site liaison with any requests for additional attention or activities to be performed at the site within 24 hours of completing the survey.

The specific methods used to complete a challenge or test of the measurement and collection equipment and instrumentation at each site are unique for the type of equipment and the instrumentation present at the particular MDN site. Specific SOPs have been developed for that purpose.

## 2.1 Instrument Specific Methods

The list of approved MDN site equipment and instrumentation is presented in Section 1.1. The preliminary survey activities identify which of the listed types of instrumentation are present at each site. Table 3 identifies the specific SOP for the equipment or instrumentation type.

**Table 3. Instrument Specific Methods**

| SOP Name | SOP Number | Revision Number | Revision Date |
|---|---|---|---|
| Belfort 5-780 Precipitation Gauge | SOP-EPW07061-1400 | 1 | May 2008 |

| | | | |
|---|---|---|---|
| OTT NADP Pluvio Electronic Precipitation Gauge | SOP-EPW07061-1410 | 1 | May 2008 |
| ETI NOAH IV Precipitation Gauge | SOP-EPW07061-1420 | 1 | May 2008 |
| ACM MDN Precipitation Collector | SOP-EPW07061-1320 | 1 | May 2008 |
| N-CON MDN Precipitation Collector | SOP-EPW07061-1330 | 1 | May 2008 |

Using this SOP and those presented in Table 3, any currently operating MDN site can be surveyed. As new equipment or instrumentation is approved for use at MDN sites, new methods and procedures will be developed to challenge and test that equipment and instrumentation. Those methods will be incorporated into this SOP and Table 3.

# 3.0 Health and Safety Warnings

The NADP Site Survey Program and MDN Site Performance Survey require travel to various locations and assessing the condition and operation of electrical devices. As such there are some health and safety warnings and cautions that must be observed.

## 3.1 Electrical

The sample collection devices, and some of the precipitation gauges, are powered by 120 volt AC power. This is the typical household electrical service which powers most common appliances. The same cautions practiced for any device powered by this means should be observed for the site equipment.

In some cases the power may be delivered using extension cords or buried electrical wires. Particular attention should be paid to the manner and condition of the power supply and distribution. No digging or under-ground probing should be conducted without first identifying all buried services.

Prior to removing any instrument electrical service covers or fuses, disconnect the power source to the instrument. This can be accomplished by unplugging the power cord or tuning off the circuit breaker and employing a proper “lockout” and “tag-out” procedure.

### 3.1.1 Lockout Tag-out

“Lockout” “tag-out” (LOTO) procedures are intended to protect survey personnel and technicians from electrical hazards while troubleshooting and servicing electrical equipment. If the power supply to the device is not in the direct control of the technician, LOTO procedures must be used to ensure that the power is not supplied to the device during the activities. This is accomplished by locating the source of the power (electrical outlet or circuit distribution panel) and

disconnecting the power source. Unplugging the cord or turning the circuit breaker off will then disconnect the power. In rare instances it may be necessary to disconnect the main power supply or main breaker that supplies power to all of the circuits in the distribution panel.

After the power supply has been disconnected access to the panel or outlet must be locked and tagged with a notice for other personnel that service is being conducted on a component of that circuit. This is intended to prevent the circuit from being activated by other personnel that may enter the area and not realize that a technician is working on a device on that circuit.

### 3.2 Remote Locations

Some of the stations in the MDN are located in remote areas. Access to the site may be limited to hiking trails. The trails may be mountainous, or rugged and steep, and at high elevations. Shelter may not be available at the site location. Caution and care should be exercised to prevent overexertion when accessing these sites. Protective clothing and boots should be worn, and adequate fluids should be available for the duration of the site visit.

### 3.3 Travel and Driving

By far the most dangerous activity undertaken during the site survey program is travel by driving to the site locations. All safety regulations recommended for the operation of motor vehicles must be observed. This includes the use of seatbelts and shoulder restraints.

All operators must have a valid operator's license and the insurance required by both the issuing agency and the contract (or subcontract) clauses.

The consumption of alcohol or other drugs that may cause impairment are not permitted prior to or while operating a motor vehicle.

Extended travel and long working hours can cause stress and fatigue. These conditions can adversely affect ones ability to operate a motor vehicle. Personnel must be aware of stress and fatigue levels and not operate a motor vehicle under these conditions. Personnel are urged to get the necessary rest required to stay alert while driving.

## 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years

of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the MDN. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

### 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

## 5.0 Equipment and Supplies

Together with this SOP, the individual instrument SOPs listed here are required for conducting performance surveys at MDN designated NADP precipitation collection stations. They are intended to be used by qualified technicians that understand general instrument operation and survey techniques. The following SOPs provide technical guidance and detailed information regarding specific NADP MDN site survey procedures:

- SOP-EPW07061-1400 – ***Belfort 5-780 Precipitation Gauge (NADP Installations)***
- SOP-EPW07061-1410 – ***OTT NADP Pluvio Electronic Precipitation Gauge (NADP Installations)***
- SOP-EPW07061-1420 – ***ETI NOAH IV Precipitation Gauge (NADP Installations)***
- SOP-EPW07061-1320 – ***ACM MDN Precipitation Collector - (NADP Installations)***
- SOP-EPW07061-1330 – ***N-CON MDN Precipitation Collector - (NADP Installations)***

### 5.1 Survey Tools and Materials

In addition to the specific instruments and equipment listed in the individual SOPs, the following materials are required to perform NADP MDN site surveys.

- NADP MDN QAPP.
- Site Survey File for each site in the planned trip.
- Hardcopy data forms (forms provided in each Site Survey File).
- Laptop computer with approved FSSD.

- Global Positioning System (GPS).
- Miscellaneous recordkeeping supplies.
- Manufacturer's instruction manuals.

# 6.0 Instrument or Method Calibration and Standardization

Each method used to challenge or test a measurement or collection device deployed at NADP MDN site will be referenced to a carefully calibrated and certified standard. The rational and development of those procedures is discussed below.

## 6.1 Standard Weights

The majority of challenges performed on measurement systems at MDN sites will be the use of a standard weight to simulate precipitation and then comparing the instrument response to the equivalent precipitation that corresponds to the standard weight. The equivalent precipitation amount is a function of the size of the opening in the particular precipitation gauge and the calibration of the gauge itself.

In order to accurately determine the equivalent precipitation amount, an accurate measurement of each standard weight must be performed. This will be accomplished at the EEMS facility with a precision electronic balance. The balance will be certified annually by an independent organization using standard reference methods and materials. EEMS will check the calibration of the balance prior to each use with transfer weights that are certified at the time of the balance certification. The balance calibration weights will be maintained at the EEMS facility in a manner that protects their condition and weight.

### 6.1.1 Instrument Sensitivity to Weight/Mass

The various precipitation gauges approved for MDN respond differently to the weight applied to the catch basin. For example the Belfort gauges respond with an equivalent precipitation amount of approximately one inch when a weight of approximately 825 grams is added to the bucket. This will be the smallest standard weight used for the Belfort gauges, and measured to the hundredth of one inch. The electronic ETI and OTT Pluvio gauges are more sensitive and will be challenged with much smaller weights that correspond to precipitation amounts of 0.25 and 0.50 inches.

All weights will be checked and their weight documented at EEMS during the preparation of the Site Survey Kit. Using the precisely measured weight the corresponding equivalent precipitation

amount will be calculated for the intended gauge and included with the kit. The weights will be properly packed and handled in order to preserve their condition during the site survey trips.

### 6.2 Temperature Checks

Precipitation collector operation is triggered by a sensor that detects the presence of precipitation. The sensor is heated to evaporate the precipitation following an event so the collector does not remain open exposing the sample.

The temperature of the sensor will be measured by a transfer temperature probe that is calibrated and referenced to a standard. This will be performed annually and the results documented in each Site Survey Kit, and in each Site Survey File.

### 6.3 Voltage Checks

The MDN Site Performance Surveys will include various voltage checks of the instruments and equipment. Those checks will be performed using a certified multimeter. The multimeter will be certified annually by an independent organization. Certification documentation will be included with each Site Survey Kit, and each Site Survey File.

## 7.0 Troubleshooting

One function of the NADP Site Survey Program is the routine maintenance and minor repair of the site equipment to continue or restore the operation to the NADP specifications. In order to perform this function some troubleshooting of malfunctioning equipment or instrumentation may be necessary. The instructions provided to site operators by the NADP PO and the manuals provided by the instrument manufacturers will be utilized to perform the troubleshooting procedures. The experience of the site Survey Technician will ensure exceptional troubleshooting techniques.

The list of items that are routinely addressed during a MDN Site Performance Survey is included in Table 4 of the NADP Site Survey Program QAPP.

### 7.1 Site Survey Instrument Function

The tools, instruments, standards, and materials that make up each Site Survey Kit are carefully controlled, tested, calibrated and maintained by the EEMS QA staff. This process is intended to ensure proper and accurate function when the kit is used in the field. Should any of the items

malfunction during a site survey trip, troubleshooting will be performed in the same manner by the site survey team with the assistance of the EEMS QA Manager.

If any field repairs are performed on items in the survey kit, the EEMS QA Manager will determine if the certification of that item and survey results measured by that item are compromised. If necessary a replacement item will be sent to the Survey Technician to ensure accurate survey results.

# 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition at most of the MDN sites is accomplished by visual observations, made by site operators, and site instrument measurements on hardcopy media (rain gauge charts). These are manually recorded to hardcopy forms by the site operator and then sent to the HAL. As electronic precipitation gauges are deployed at MDN sites data acquisition will be accomplished by radio transmission to handheld data devices and then electronically sent to the HAL. Some sites will also employ direct telemetry from the site equipment to the HAL.

## 8.1 Post-Site Survey Procedures

At this point the information gathered during the site survey will be recorded on the data forms associated with data collection for each measurement process or system. The data forms comprise the complete Site Survey Questionnaire which is included in Appendix B.

The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the EPA, the NADP PO, and other data users. The method and tasks to be completed after recording survey data are described in the following sections.

## 8.2 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

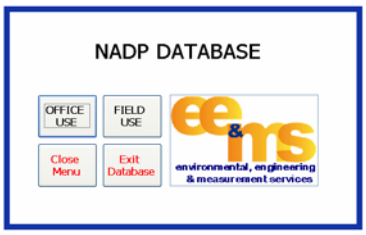



**Figure 2. User Type Selection Menu**

### 8.2.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists,

one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 2 shows this first screen.

### 8.2.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

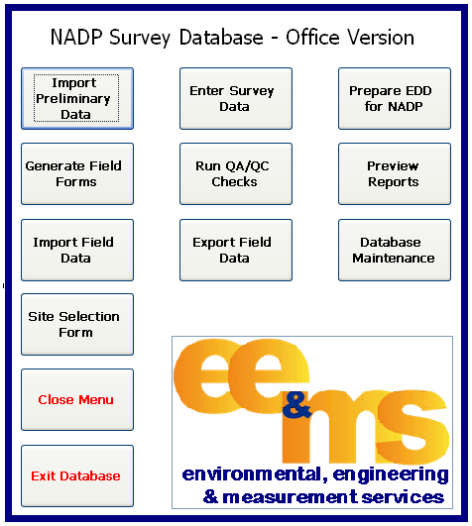



**Figure 3. NADP Survey Database – Office Version Main Menu**

### 8.2.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 4 shows the different options the user can choose form:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

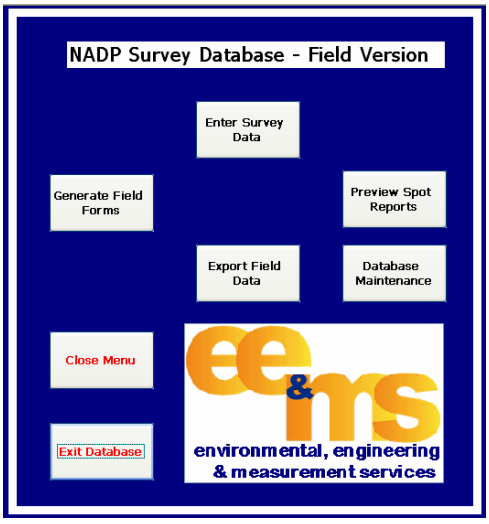



**Figure 4. NADP Survey Database – Field Version Main Menu**

### 8.2.4 Enter Survey Data

The Enter Survey Data menu (Figure 5) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

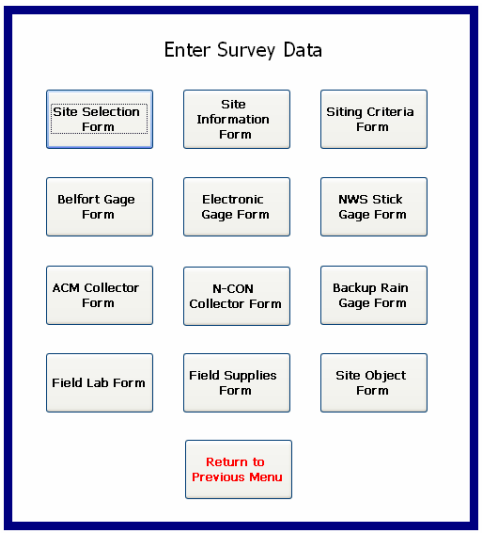



**Figure 5. Enter Survey Data Menu**

### 8.2.5 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 6 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

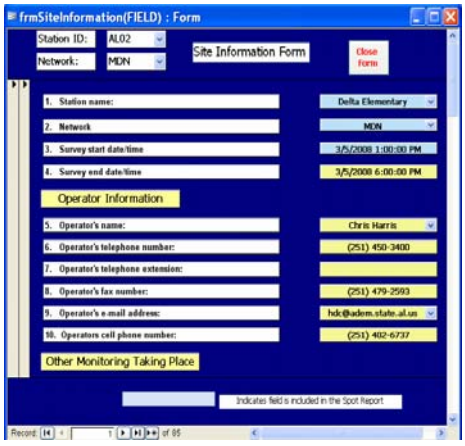



**Figure 6. Site Information Form (Field Form)**

### 8.2.6 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 7):

- Revised Spot Reports

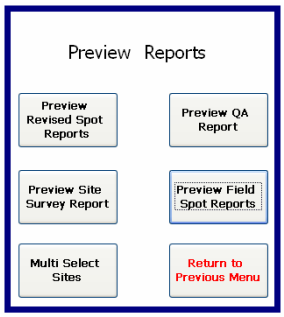



**Figure 7. Preview Reports Menu**

- Site Survey Reports
- Field Spot Report
- QA Report

## 8.3 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.4 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.5 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

## 8.6 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

# 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data at the MDN sites. Some sites utilize handheld data devices as previously described, and their use is anticipated to increase as more electronic gauges are installed.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

## 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

## 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.0 and subsections.

After data entry the required Spot Report can be generated and distributed. This will contain the maintenance items required (if any) at the site. The electronic data tables will also be generated and exported to the duplicate database at EEMS.

### 9.2.1 Field Data Backup

Each Site Survey Kit will contain a “thumb drive” (or flash) memory device capable of storing all the data tables containing the survey data, and digital photos acquired during the site survey trip. After entering the survey data for each site, all data will be copied to the thumb drive for backup. This procedure will continue for each site in the survey trip. At the conclusion of the trip, the thumb drive will be sent with the final hardcopy data forms from the last site visited, separately from the field computer which at this point will also contain a copy of the same information. Prior to the field computer and Site Survey Kit being sent back to EEMS, two copies of the site survey data tables and all other information (digital photos, electronic reports, etc) will be written to compact disc (CD). One disc will be included with the Site Survey Kit and returned to EEMS, and one disc will be kept by the Survey Technician for his or her records.

# 10.0 Data Management and Records Management

Most of the data and records management procedures have been discussed throughout the previous sections. Particularly the preliminary Site Survey File data gathering process and the field site survey data gathering and management processes. This section and subsequent subsections describes the management of the final site survey data and Site Survey File at EEMS.

## 10.1 Shipping and Tracking

As mentioned in Subsection 1.2.2, prior to conducting site visits, the Site Survey File will contain all the preliminary information gathered, and the record of shipment and receipt of the Site Survey Kit. As information is received at EEMS following site visits, it is logged and that record is added to the Site Survey File.

The QA Manager will oversee the process of receiving the electronic data export from the field and the importation of that data into the duplicate database at EEMS. After the original hardcopy data forms have been received and logged the duplicate data entry process will begin.

## 10.2 Duplicate Data Entry and Reconciliation

As a QC check, duplicate data entry will be performed for designated site survey data fields, most of which will be numeric data results. The intention of duplicate data entry is to minimize typographical errors. Theoretically it is unlikely for two different people to make the same mistake when entering the same data. Therefore by comparing both entries the mistakes made during each entry will be identified. The duplicate entry will be performed at EEMS by personnel other than the site Survey Technician. The entry will be overseen by the QA Manager.

Following the duplicate data entry process the data tables will be automatically compared for differences. Any difference will automatically be flagged for further investigation. The QA Manager will be responsible for reconciling any differences by reference to the original hardcopy data form or discussion with the Survey Technician or site operator.

A record of the differences found and the resolution of the differences will be added to the Site Survey File and included in the monthly progress and management reports. If for any reason a difference cannot be resolved, it will be identified for further action and all actions will be reported in monthly progress reports.

## 10.3 Final Data Set

After the QA manager has ensured that all of the steps described above have been performed and approved the site survey data tables, the site survey data is considered final. At this stage in the management process following entry of each and every site survey data set, the database is backed up to an external hard drive on-site and off-site.

### 10.3.1 Site Survey Performance Report

From the final data set a Site Survey Performance Report is generated and distributed for each site survey. This report will address any differences that may have been reported in the Spot Report. The Project Manager will be responsible for generating and distributing this report. The electronic Site Survey Performance Reports will be delivered within 15 days from the site survey. Other hardcopy information such as edited site sketches will be mailed to the NADP PO. Copies of all information will be retained and added to the Site Survey File.

Following delivery of the Site Survey Performance Report and any hardcopy information, the Site Survey File for the completed site will be closed and archived. The DCN will indicate the Site ID, Network ID, and the date of the survey to allow for retrieval if requested. A new Site Survey File will be initiated at least one month prior to the next scheduled site survey.

### 10.3.2 Electronic Data Delivery

Electronic data delivery (EDD) files will be delivered with the monthly progress reports for those months when site surveys were conducted. The format of the EDD will be developed with the assistance of the NADP PO and suitable for import into the NADP database. The electronic data files will contain all of the information included in the Site Survey Performance Report. The EDD files will also contain all other digital information collected during the site survey such as digital photographs.

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one QA/QC role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following

sections describe the quality process that is not only employed for MDN Site Performance Survey procedures, but for all projects at EEMS

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

### 11.2.1 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

environmental, engineering & measurement services

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# Quality Assurance/Quality Control Documentation

| | |
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**List of Acronyms and Abbreviations**

| | |
|---|---|
| AIRMoN | Atmospheric Integrated Research Monitoring Network |
| CAL | Central Analytical Laboratory |
| CD | compact disc |
| DAS | data acquisition system |
| DCN | document control number |
| EDD | electronic data delivery |

**List of Acronyms and Abbreviations (continued)**

| | |
|---|---|
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FORF | Field Observer Report Form |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| GPS | Global Positioning System |
| HAL | Mercury Analytical Laboratory |
| ISWS | Illinois State Water Survey |
| LOTO | lockout tag-out |
| NADP | National Atmospheric Deposition Program |
| NIST | National Institute of Standards and Technology |
| PDA | Personal Digital Assistant |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| SOP | standard operating procedure |

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# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes an overview of the procedures for conducting performance surveys of National Atmospheric Deposition Program (NADP) Atmospheric Integrated Research Network (AIRMoN) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. AIRMoN is one of the three networks of the NADP and is focused on long-term trends of pollutant ion concentrations in precipitation and estimations of wet atmospheric deposition. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations. More specific instructions are provided in separate SOPs for each measurement system usually found at an AIRMoN station. Those systems include precipitation gauges and precipitation collectors. The individual SOPs are referenced in Section 5.0 Equipment and Supplies of this SOP.

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the AIRMoN Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

AIRMoN Site Performance Surveys include:

- Verifying that the site equipment and associated systems are capable of making valid and accurate measurements.
- Verifying that the precipitation collector is operating within the specifications of the AIRMoN QAPP and capable of collecting valid samples.
- Challenging precipitation gauge with an independent audit standard [traceable to National Institute of Standards and Technology (NIST) or other authoritative standard] to determine if the device is operating within defined project accuracy goals provided in the AIRMoN QAPP.
- Performing routine maintenance and/or minor repairs if necessary to return the site equipment to operation within the designated specifications.
- Subsequently re-challenging and/or retesting the equipment.
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD).
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD.

- Distributing the survey results, reports, and documentation to the designated project personnel.

## 1.1 Typical AIRMoN Site Installations

The AIRMoN Site Performance Survey program is intended to assess the operation of each site in the network. The network currently consists of approximately 7 sites in the eastern United States. The number and location of operational sites varies at any time. A list of active sites and locations can be found in the "Quality Assurance Project Plan (QAPP) – Support for Conducting Systems and Performance Surveys of National Atmospheric Monitoring Stations" (referred to from this point on as NADP Site Survey Program QAPP). An updated list may be available on the NADP website: http://nadp.sws.uiuc.edu/.

The program goal is to visit and survey approximately 90 total sites per year from the three individual networks and each site in the NADP once approximately every three years. The current survey schedule can be found at ftp://67.192.214.230 in the NADP Final directory.

Specific equipment at each site can vary, but each site will consist of an approved precipitation gauge, an approved precipitation collector, field laboratory instrumentation, equipment manuals, approved operating procedures, and site supplies. The approved AIRMoN measurement and sampling equipment includes:

- Belfort 5-780 Mechanical Precipitation Gauge
- NWS Stick Precipitation Gauge
- Aerochem Metrics (ACM type) Precipitation Collector
- Ohaus Mechanical Balance
- Various electronic Scales
- Various pH meters
- Various conductivity meters

## 1.2 Preliminary Survey Activities

Due to the number and location of the sites in the network, the AIRMoN site survey program is a travel intensive project. In order to maintain an efficient schedule and quality product, frequent and concise communication with project personnel is required. Prior to beginning travel, the U.S. Environmental Protection Agency (EPA) Project Officer and site liaisons at the NADP Program Office (PO), and Central Analytical Laboratory (CAL) at Illinois State Water Survey (ISWS), must be contacted. Their contact information is listed below:

- Michael Kolian 202-343-9261 kolian.michael@epa.gov EPA Project Officer
- Melissa Rury 202-343-9882 rury.melissa@epa.gov EPA Project Officer

- Jane Rothert 217-333-7942 airmon@uiuc.edu AIRMoN Liaison
- Roger Claybrooke 217-244-2838 dclay@sws.uiuc.edu NADP PO
- Mark Rhodes 217-244-6413 Rhodes1@illinois.edu NADP QA Manager

In order to adhere to the schedule set forth in the NADP Site Survey Program QAPP, the above listed personnel must be contacted no less than one month prior to the planned date of the site survey. The initial communication must include the information contained in Table 1 for each planned site survey.

**Table 1. Preliminary Site Communication Information**

| Site Name | Site ID | Survey Date | Previous Survey Date | NADP Network(s) |
|---|---|---|---|---|
| Site #1 | | | | AIRMoN |
| Site #2 | | | | |
| Site #3 | | | | |
| : | | | | |

Information obtained from the NADP liaisons during the preliminary communication should include the information contained in Table 2 below for each site.

**Table 2. Initial Site Information**

| | Existing Information |
|---|---|
| Site operator (name, address, phone, e-mail) | |
| Site supervisor (name, address, phone, e-mail) | |
| Site sponsor contact (name, address, phone, e-mail) | |
| Precipitation gauge (manufacturer, model) | |
| Collector (manufacturer, model) | |
| Balance (manufacturer, model) | |
| pH meter (manufacturer, model) | |
| Conductivity meter (manufacturer, model) | |
| Site characteristics (i.e., solar power, remote, etc) | |
| Known problems (equipment and/or siting related) | |
| Additional requests (training issues, etc) | |
| Logistical concerns (i.e., passes or keys required, etc) | |
| Site sketch available and provided (pdf file name) | |

Figure 1 is an example of the initial site information for AIRMoN site PA15 as received from the NADP PO.

**Figure 1. NADP Pre-Audit Site Information AIRMoN Site PA15**

**National Atmospheric Deposition Program**
**Pre-Audit Site Information**
**AIRMoN Site PA15**

| | | | |
|---|---|---|---|
| Site ID | PA15 | Site Name | Penn State |
| Latitude | 40.7883 | County | Centre |
| Longitude | -77.9458 | Sponsoring Agency | NOAA-Air Resources Laboratory |
| Elevation | 393 | Operating Agency | NOAA-Air Resources Laboratory |
| Start | 10/6/1992 | Site Owner | Pennsylvania Game Commission |
| Stop | | Map | JULIAN, 1971 |
| Status | A | | |

**Installed Equipment**

| Wet/Dry Sampler | | Primary Rainguage | Field Lab |
|---|---|---|---|
| Type | | Type | Scale |
| Power | U | Shield | pH Meter |
| Heated | | Distance to WD | pH Electrode |
| Lid | | **Backup Rainguage** | Cond. Meter |
| Event Recorder | | Type | Cond. Cell |
| | | Distance to WD | |

| | Supervisor | Operator |
|---|---|---|
| Name | Scott Richardson | Robert Ziegler |
| Phone | 814-574-3232 | 814-865-2916 |
| Alt Phon | | |
| Fax | 814-865-3663 | |
| Email | srichardson@psu.edu | rfzi@psu.edu |
| Training | | 5/1/2001(1) |
| | Scott Richardson<br>Penn State University<br>Department of Meteorology<br>414 Walker Building<br>University Park, PA 16802 | Robert Ziegler<br>Meteorology Department<br>Penn State University<br>503 Walker Building<br>University Park, PA 16802 |

**Funding Contact**

Name
Phone
Alt Phon
Fax
Email

**Observers**

After obtaining the site contact information from the site liaisons, the site operators and supervisors for each site in the planned trip must be contacted by telephone at least two weeks prior to the planned site visit. If the planned survey will be the first survey for a particular site (i.e., Previous Survey Date = null), the site sponsor for that site will also be contacted by phone and notified of the survey.

Discussions with the site personnel will include logistics pertaining to accessing the site, date and time of the planned site survey, any modifications that may have been performed on the site instrumentation, and any operational problems that may exist at the site. All relevant information will be added to the data gathered during the preliminary communication with the site liaisons.

Once the initial communication with the site liaisons and site operator has occurred, the comprehensive information obtained for each site will be compiled and included in a Site Survey File.

### 1.2.1 Preliminary Site Survey File

At this point, during the preliminary survey activities, the Site Survey File will contain the compiled comprehensive information obtained during the preliminary communication and data gathering process described above. The information for each site will include records of phone calls, e-mail correspondence, and completed site information data tables.

The file will become a permanent historical record of site survey information and documentation. It will be assigned a Document Control Number (DCN) and will become part of the site survey data management system. Appropriate site information obtained thus far will be entered (or imported) into the FSSD. Initial site data forms will then be generated and included in the Site Survey File and copied and included in the Site Survey Kit to be provided to the Survey Technician responsible for conducting the site survey.

### 1.2.2 Site Survey Kit

At this step in the performance survey procedures, a Site Survey Kit will be prepared at EEMS. The Site Survey Kit will be assembled utilizing the preliminary information gathered for each site. The site-specific tools, equipment, maintenance items, forms, certification records, Personal Digital Assistant (PDA), field computer with FSSD, and survey supplies required to perform the survey of each site in the planned trip will be inventoried and packed for shipment.

Arrangements will be made with the Survey Technician for the shipment of the kit to the field. Upon receipt of the Site Survey Kit, the Survey Technician will inspect the kit and report any damage or missing articles. After completing any additional shipments that may be necessary, the Site Survey Kit inventory and shipping log will be included in the Site Survey File.

The EEMS quality assurance (QA) Manager will oversee the process of completing the preliminary Site Survey File, and providing the Survey Technician with the required materials to complete the planned surveys. Once receipt of the complete and functional survey kit is confirmed by the Survey Technician, the preliminary Site Survey File is complete. Post-survey information will be included following the site visit and survey by the Survey Technician.

# 2.0 Summary of Methods

General methods used for performing an AIRMoN Site Performance Survey will include the completion of the preliminary survey activities described in the previous sections and then:

- Traveling to the site and challenging or testing each measurement and collection device according to the SOP for that device,
- Recoding the observed and collected data on the appropriate form,
- Performing any routine maintenance, adjustment, or minor repair,
- Repeating the challenge or test of the device,
- Recording the results of the additional challenge or test,
- Entering the recorded data into the FSSD and backing up the files,
- Generating the exit report (Spot Report) of the survey activities from the FSSD within 24 hours of completing the survey,
- Transferring the hardcopy recorded data and the electronic FSSD files to the EEMS data management facility,
- Verbally reporting the results of the survey to the site liaison with any requests for additional attention or activities to be performed at the site within 24 hours of completing the survey.

The specific methods used to complete a challenge or test of the measurement and collection equipment and instrumentation at each site are unique for the type of equipment and the instrumentation present at the particular AIRMoN site. Specific SOPs have been developed for that purpose.

## 2.1 Instrument Specific Methods

The list of approved AIRMoN site equipment and instrumentation is presented in Section 1.1. The preliminary survey activities identify which of the listed types of instrumentation are present at each site. Table 3 identifies the specific SOP for the equipment or instrumentation type.

**Table 3. Instrument Specific Methods**

| SOP Name | SOP Number | Revision Number | Revision Date |
|---|---|---|---|
| Belfort Mechanical Precipitation Gauge | SOP-EPW07061-1400 | 1 | May 2008 |
| NWS Stick Precipitation Gauge | SOP-EPW07061-1430 | 1 | May 2008 |
| ACM NTN Precipitation Collector | SOP-EPW07061-1310 | 1 | May 2008 |
| pH meter | SOP-EPW07061-1220 | 1 | May 2008 |
| Conductivity meter | SOP-EPW07061-1230 | 1 | May 2008 |
| Ohaus balance | SOP-EPW07061-1210 | 1 | May 2008 |

Using this SOP and those presented in Table 3, any currently operating AIRMoN site can be surveyed. As new equipment or instrumentation is approved for use at AIRMoN sites, new methods and procedures will be developed to challenge and test that equipment and instrumentation. Those methods will be incorporated into this SOP and Table 3.

## 2.2 Post-Site Survey Procedures

This section describes the tasks required after completing the on-site tasks which have been described in Sections 1.0 and 2.0, and after completing the procedures in the instrument specific survey methods for all of the site instrumentation.

At this point the information gathered during the site survey will be recorded on the data forms associated with data collection for each measurement process or system. The data forms comprise the complete Site Survey Questionnaire which is included in Appendix B.

### 2.2.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

# 3.0 Health and Safety Warnings

The NADP Site Survey Program and AIRMoN Site Performance Survey require travel to various locations and assessing the condition and operation of electrical devices. As such there are some health and safety warnings and cautions that must be observed.

## 3.1 Electrical

The sample collection devices, and some of the precipitation gauges, are powered by 120 volt AC power. This is the typical household electrical service which powers most common appliances. The same cautions practiced for any device powered by this means should be observed for the site equipment.

In some cases the power may be delivered using extension cords or buried electrical wires. Particular attention should be paid to the manner and condition of the power supply and distribution. No digging or under-ground probing should be conducted without first identifying all buried services.

Prior to removing any instrument electrical service covers or fuses, disconnect the power source to the instrument. This can be accomplished by unplugging the power cord or tuning off the circuit breaker and employing a proper “lockout” and “tag-out” procedure.

### 3.1.1 Lockout Tag-out

“Lockout” “tag-out” (LOTO) procedures are intended to protect survey personnel and technicians from electrical hazards while troubleshooting and servicing electrical equipment. If the power supply to the device is not in the direct control of the technician, LOTO procedures must be used to ensure that the power is not supplied to the device during the activities. This is accomplished by locating the source of the power (electrical outlet or circuit distribution panel) and disconnecting the power source. Unplugging the cord or turning the circuit breaker off will then disconnect the power. In rare instances it may be necessary to disconnect the main power supply or main breaker that supplies power to all of the circuits in the distribution panel.

After the power supply has been disconnected access to the panel or outlet must be locked and tagged with a notice for other personnel that service is being conducted on a component of that circuit. This is intended to prevent the circuit from being activated by other personnel that may enter the area and not realize that a technician is working on a device on that circuit.

## 3.2 Remote Locations

Some of the stations in the AIRMoN may be located in remote areas. Access to the site may be limited to hiking trails. The trails may be mountainous, or rugged and steep, and at high elevations. Shelter may not be available at the site location. Caution and care should be exercised to prevent overexertion when accessing these sites. Protective clothing and boots should be worn, and adequate fluids should be available for the duration of the site visit.

### 3.3 Travel and Driving

By far the most dangerous activity undertaken during the site survey program is travel by driving to the site locations. All safety regulations recommended for the operation of motor vehicles must be observed. This includes the use of seatbelts and shoulder restraints.

All operators must have a valid operator's license and the insurance required by both the issuing agency and the contract (or subcontract) clauses.

The consumption of alcohol or other drugs that may cause impairment are not permitted prior to or while operating a motor vehicle.

Extended travel and long working hours can cause stress and fatigue. These conditions can adversely affect ones ability to operate a motor vehicle. Personnel must be aware of stress and fatigue levels and not operate a motor vehicle under these conditions. Personnel are urged to get the necessary rest required to stay alert while driving.

## 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the AIRMoN. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

### 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

Together with this SOP, the individual instrument SOPs listed here are required for conducting performance surveys at AIRMoN designated NADP precipitation collection stations. They are intended to be used by qualified technicians that understand general instrument operation and survey techniques. The following SOPs provide technical guidance and detailed information regarding specific NADP AIRMoN site survey procedures:

- SOP-EPW07061-1400 – ***Belfort Precipitation Gauge Standard Operating Procedures (NADP Installations).***
- SOP-EPW07061-1430 – ***National Weather Service (Stick) Gauge , Standard Operating Procedures (NADP Installations)***.
- SOP-EPW07061-1220 – ***pH meter Standard Operating Procedures (NADP Installations)***.
- SOP-EPW07061-1310 – ***ACM NTN Precipitation Collector Standard Operating Procedures (NADP Installations)***.
- SOP-EPW07061-1230 – ***conductivity meter Standard Operating Procedures (NADP Installations)***
- SOP-EPW07061-1210 – ***Ohaus balance Standard Operating Procedures (NADP Installations)***

## 5.1 Survey Tools and Materials

In addition to the specific instruments and equipment listed in the individual SOPs, the following materials are required to perform NADP AIRMoN site surveys.

- NADP AIRMoN QAPP.
- Standard pH and conductivity samples from the CAL
- Site Survey File for each site in the planned trip.
- Hardcopy data forms (forms provided in each Site Survey File).
- Laptop computer with approved FSSD.
- Global Positioning System (GPS).
- Miscellaneous recordkeeping supplies.
- Manufacturer's instruction manuals.

# 6.0 Instrument or Method Calibration and Standardization

Each method used to challenge or test a measurement or collection device deployed at NADP AIRMoN site will be referenced to a carefully calibrated and certified standard. The rational and development of those procedures is discussed below.

## 6.1 Standard Weights

The majority of challenges performed on measurement systems at AIRMoN sites will be the use of a standard weight to simulate precipitation and then comparing the instrument response to the equivalent precipitation that corresponds to the standard weight. The equivalent precipitation amount is a function of the size of the opening in the particular precipitation gauge and the calibration of the gauge itself.

In order to accurately determine the equivalent precipitation amount, an accurate measurement of each standard weight must be performed. This will be accomplished at the EEMS facility with a precision electronic balance. The balance will be certified annually by an independent organization using standard reference methods and materials. EEMS will check the calibration of the balance prior to each use with transfer weights that are certified at the time of the balance certification. The balance calibration weights will be maintained at the EEMS facility in a manner that protects their condition and weight.

### 6.1.1 Instrument Sensitivity to Weight/Mass

The various precipitation gauges approved for AIRMoN respond differently to the weight applied to the catch basin. For example the Belfort gauges respond with an equivalent precipitation amount of approximately one inch when a weight of approximately 825 grams is added to the bucket. This will be the smallest standard weight used for the Belfort gauges, and measured to the hundredth of one inch. The electronic ETI and OTT Pluvio gauges are more sensitive and will be challenged with much smaller weights that correspond to precipitation amounts of 0.25 and 0.50 inches.

All weights will be checked and their weight documented at EEMS during the preparation of the Site Survey Kit. Using the precisely measured weight the corresponding equivalent precipitation amount will be calculated for the intended gauge and included with the kit. The weights will be properly packed and handled in order to preserve their condition during the site survey trips.

## 6.2 Temperature Checks

Precipitation collector operation is triggered by a sensor that detects the presence of precipitation. The sensor is heated to evaporate the precipitation following an event so the collector does not remain open exposing the sample.

The temperature of the sensor will be measured by a transfer temperature probe that is calibrated and referenced to a standard. This will be performed annually and the results documented in each Site Survey Kit, and in each Site Survey File.

### 6.3 Voltage Checks

The MDN Site Performance Surveys will include various voltage checks of the instruments and equipment. Those checks will be performed using a certified multimeter. The multimeter will be certified annually by an independent organization. Certification documentation will be included with each Site Survey Kit, and each Site Survey File.

## 7.0 Troubleshooting

One function of the NADP Site Survey Program is the routine maintenance and minor repair of the site equipment to continue or restore the operation to the NADP specifications. In order to perform this function some troubleshooting of malfunctioning equipment or instrumentation may be necessary. The instructions provided to site operators by the NADP PO and the manuals provided by the instrument manufacturers will be utilized to perform the troubleshooting procedures. The experience of the site Survey Technician will ensure exceptional troubleshooting techniques.

The list of items that are routinely addressed during a AIRMoN Site Performance Survey is included in Table 4 of the NADP Site Survey Program QAPP.

### 7.1 Site Survey Instrument Function

The tools, instruments, standards, and materials that make up each Site Survey Kit are carefully controlled, tested, calibrated and maintained by the EEMS QA staff. This process is intended to ensure proper and accurate function when the kit is used in the field. Should any of the items malfunction during a site survey trip, troubleshooting will be performed in the same manner by the site survey team with the assistance of the EEMS QA Manager.

If any field repairs are performed on items in the survey kit, the EEMS QA Manager will determine if the certification of that item and survey results measured by that item are compromised. If necessary a replacement item will be sent to the Survey Technician to ensure accurate survey results.

# 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition at most of the AIRMoN sites is accomplished by visual observations, made by site operators, and site instrument measurements on hardcopy media (rain gauge charts). These are manually recorded to hardcopy forms by the site operator and then sent to the HAL. As electronic precipitation gauges are deployed at AIRMoN sites data acquisition will be accomplished by radio transmission to handheld data devices and then electronically sent to the CAL. Some sites will also employ direct telemetry from the site equipment to the CAL.

## 8.1 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the Field Observer Report Form (FORF). The AIRMoN Site Performance Survey will check and verify that those observations are being properly interpreted and recorded. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.2 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.3 Manual Calculations

As mentioned in Section 8.1 the calculations performed by the site operator will be checked as part of the site systems survey. Site performance survey calculations will be performed manually by the Survey Technician during the challenge or test of each instrument. The calculations will include:

- The difference of the observed (or measured) instrument response, from the actual (or standard) test value.
- Linear regression of multiple test values versus response of electronic precipitation gauges.

- The difference of the observed (or measured) instrument response from the prescribed (or target) value.

The results of the calculations will determine if the instrument meets the acceptance criteria set forth in Table 3 of the NADP Site Survey Program QAPP. The results of the calculations will be recorded on the survey data forms.

### 8.3.1 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the EPA, the NADP PO, and other data users. The method and tasks to be completed after recording survey data are described in the following sections.

## 8.4 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

### 8.4.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 2 shows this first screen.

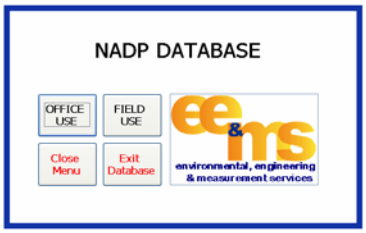



**Figure 2. User Type Selection Menu**

### 8.4.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

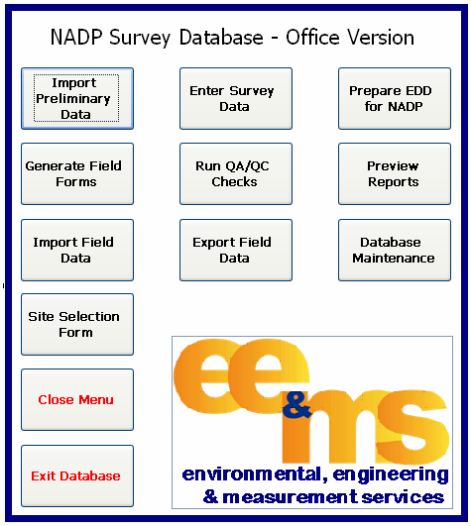



**Figure 3. NADP Survey Database – Office Version Main Menu**

### 8.4.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 4 shows the different options the user can choose form:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

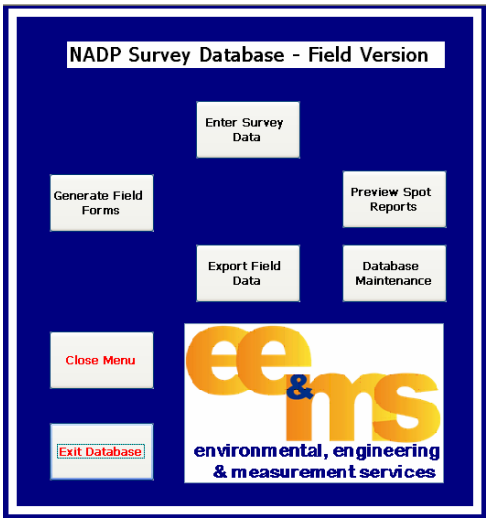



**Figure 4. NADP Survey Database – Field Version Main Menu**

### 8.4.4 Enter Survey Data

The Enter Survey Data menu (Figure 5) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

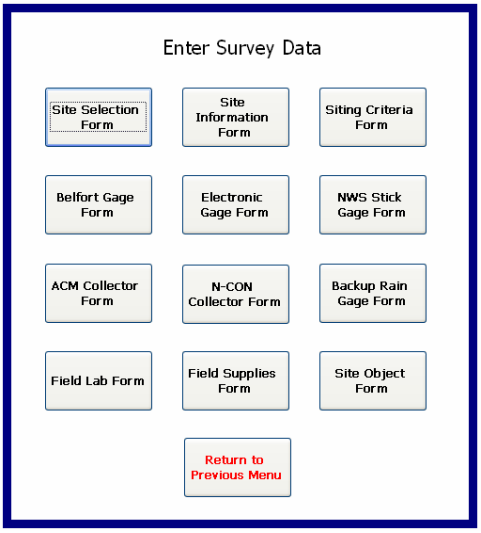



**Figure 5. Enter Survey Data Menu**

### 8.4.5 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 6 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

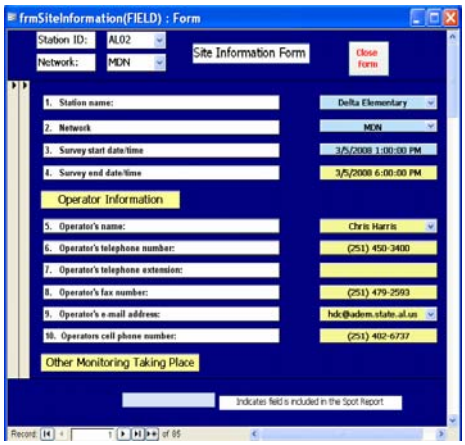



**Figure 6. Site Information Form (Field Form)**

### 8.4.6 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 7):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report

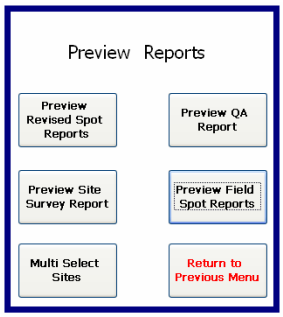



**Figure 7. Preview Reports Menu**

- QA Report

### 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

## 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data at the AIRMoN sites. Some sites may utilize handheld data devices as previously described, and their use is anticipated to increase as more electronic gauges are installed.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

### 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

### 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 2.2 and subsections.

After data entry the required Spot Report can be generated and distributed. This will contain the maintenance items required (if any) at the site. The electronic data tables will also be generated and exported to the duplicate database at EEMS.

### 9.2.1 Field Data Backup

Each Site Survey Kit will contain a "thumb drive" (or flash) memory device capable of storing all the data tables containing the survey data, and digital photos acquired during the site survey trip. After entering the survey data for each site, all data will be copied to the thumb drive for backup. This procedure will continue for each site in the survey trip. At the conclusion of the trip, the thumb drive will be sent with the final hardcopy data forms from the last site visited, separately from the field computer which at this point will also contain a copy of the same information. Prior to the field computer and Site Survey Kit being sent back to EEMS, two copies of the site survey data tables and all other information (digital photos, electronic reports, etc) will be written to compact disc (CD). One disc will be included with the Site Survey Kit and returned to EEMS, and one disc will be kept by the Survey Technician for his or her records.

# 10.0 Data Management and Records Management

Most of the data and records management procedures have been discussed throughout the previous sections. Particularly the preliminary Site Survey File data gathering process and the field site survey data gathering and management processes. This section and subsequent subsections describes the management of the final site survey data and Site Survey File at EEMS.

## 10.1 Shipping and Tracking

As mentioned in Subsection 1.2.2, prior to conducting site visits, the Site Survey File will contain all the preliminary information gathered, and the record of shipment and receipt of the Site Survey Kit. As information is received at EEMS following site visits, it is logged and that record is added to the Site Survey File.

The QA Manager will oversee the process of receiving the electronic data export from the field and the importation of that data into the duplicate database at EEMS. After the original hardcopy data forms have been received and logged the duplicate data entry process will begin.

## 10.2 Duplicate Data Entry and Reconciliation

As a QC check, duplicate data entry will be performed for designated site survey data fields, most of which will be numeric data results. The intention of duplicate data entry is to minimize typographical errors. Theoretically it is unlikely for two different people to make the same mistake when entering the same data. Therefore by comparing both entries the mistakes made during each entry will be identified. The duplicate entry will be performed at EEMS by personnel other than the site Survey Technician. The entry will be overseen by the QA Manager.

Following the duplicate data entry process the data tables will be automatically compared for differences. Any difference will automatically be flagged for further investigation. The QA Manager will be responsible for reconciling any differences by reference to the original hardcopy data form or discussion with the Survey Technician or site operator.

A record of the differences found and the resolution of the differences will be added to the Site Survey File and included in the monthly progress and management reports. If for any reason a difference cannot be resolved, it will be identified for further action and all actions will be reported in monthly progress reports.

## 10.3 Final Data Set

After the QA manager has ensured that all of the steps described above have been performed and approved the site survey data tables, the site survey data is considered final. At this stage in the management process following entry of each and every site survey data set, the database is backed up to an external hard drive on-site and off-site.

### 10.3.1 Site Survey Performance Report

From the final data set a Site Survey Performance Report is generated and distributed for each site survey. This report will address any differences that may have been reported in the Spot Report. The Project Manager will be responsible for generating and distributing this report. The electronic Site Survey Performance Reports will be delivered within 15 days from the site survey. Other hardcopy information such as edited site sketches will be mailed to the NADP PO. Copies of all information will be retained and added to the Site Survey File.

Following delivery of the Site Survey Performance Report and any hardcopy information, the Site Survey File for the completed site will be closed and archived. The DCN will indicate the Site ID, Network ID, and the date of the survey to allow for retrieval if requested. A new Site Survey File will be initiated at least one month prior to the next scheduled site survey.

### 10.3.2 Electronic Data Delivery

Electronic data delivery (EDD) files will be delivered with the monthly progress reports for those months when site surveys were conducted. The format of the EDD will be developed with the assistance of the NADP PO and suitable for import into the NADP database. The electronic data files will contain all of the information included in the Site Survey Performance Report. The EDD files will also contain all other digital information collected during the site survey such as digital photographs.

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one QA/QC role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for AIRMoN Site Performance Survey procedures, but for all projects at EEMS

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

### 11.2.1 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

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# Quality Assurance/Quality Control Documentation

| | |
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| Document Number | SOP-EPW07061-1210 |
| Date: | September 2007 |

## Authorizations

| Title | Name | Affiliation | Signature |
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| EPA Project Officer | | | |

## Revision History

| Revision No. | Description | Date | Authorization |
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| 1 | Michael Kolian's comments | May 2008 | |
| | | | |
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**List of Acronyms and Abbreviations**

| | |
|---|---|
| AIRMoN | Atmospheric Integrated Research Monitoring Network |
| ATS | Advance Technology Systems, Inc. |
| CAL | Central Analytical Laboratory |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| ISWS | Illinois State Water Survey |
| MDN | Mercury Deposition Network |
| NADP | National Atmospheric Deposition Program |
| NIST | National Institute of Standards and Technology |
| NTN | National Trends Network |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| SOP | standard operating procedure |
| SPSQ | Site Performance Survey Questionnaire |

# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting performance surveys of the Ohaus balances located at National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The Ohaus balance is used to calculate the amount of precipitation sample collected on a weekly basis for National Trends Network (NTN) sites, and on an event basis for the Atmospheric Integrated Research Monitoring Network (AIRMoN) sites. This measurement is then used to calculate the concentrations of the ions tested for at the Central Analytical Laboratory.

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the NADP Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

Performance survey of the Ohaus balances include:

- Verifying that the instrument is capable of making valid and accurate measurements.
- Challenging the gauge with an independent audit standard [traceable to National Institute of Standards and Technology (NIST) or other authoritative standard] to determine if the device is operating within defined project accuracy goals provided in the NADP QAPP.
- Performing routine maintenance and/or minor repairs if necessary to return the gauge to operation within the designated specifications.
- Subsequently re-challenging and/or retesting the gauge.
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD).
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD.
- Distributing the survey results, reports, and documentation to the designated project personnel.

# 2.0 Summary of Methods

General methods used for performing an Ohaus balance performance survey will include:

- Documenting the existing condition on the forms provided
- Completing the “as found” or pre-maintenance challenge
- Recording the results of the pre-maintenance challenge
- Performing any required routine maintenance, calibration adjustment, or minor repair
- If required repeating the “as left” or post-maintenance challenge
- Recording the results of the additional challenge
- Entering the recorded data into the FSSD and backing up the files

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of NADP sites are addressed in the Site Performance Survey SOPs for each network (SOP-EPW07061-1010, SOP-EPW07061-1020, SOP-EPW07061-1030)

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the NTN, MDN and AIRMoN sites. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

The following tools and materials are required to conduct performance surveys of Ohaus balances:

- NADP operations manuals (NTN, MDN, and AIRMoN)
- Site Survey File for the site
- Set of standard weights
- Hardcopy data forms (forms provided in Appendix A)
- Laptop computer with approved FSSD
- Miscellaneous recordkeeping supplies
- Manufacturer's instruction manuals

# 6.0 Instrument or Method Calibration and Standardization

The method described here was developed from tested and accepted procedures developed by the Central Analytical Laboratory (CAL) at Illinois State Water Survey (ISWS) and Advanced Technology Systems, Inc. (ATS). Refinements to the method will be incorporated as the NADP Site Survey Program goes forward.

## 6.1 As Found (pre-maintenance check)

The following steps are to be performed prior to conducting any instrument maintenance or adjustment to document the existing condition and operation of the balance. (Note: two types of balances/scales are used; dual beam mechanical balances and top loading electronic scales).

1. Record observations concerning general condition and type of scale on the Site Performance Survey Questionnaire.
2. Check the zero of scale and record.
3. Then “zero” the scale and record before proceeding with survey.
4. Place 1Kg standard weight on the scale and record scale response. Repeat for stnadard weights 5Kg, 10Kg and 20Kg.
5. If weighing scale is within acceptable tolerance and is clean, perform the post-maintenance checks. If the instrument is out of tolerance, perform the instrument maintenance indicated below.

## 6.2 Instrument Maintenance

The following steps are to be performed as routine cleaning and maintenance of the mechanical balances:

1. Check that balance is level and free from vibration.
2. Clean all beam slides with clean cloth and water. Do not use oil or any lubricant on balance knives or bearings.
3. Check that the magnet faces in the base of the Trig Loop Post Assembly are clean. If debris has accumulated on the magnet faces, clean them using a piece of adhesive tape (applied sticky side out to a thin, rigid strip (e.g. ruler) and insert it into the magnet slot that the aluminum damper vane enters). Press the tape against the magnet face to collect any debris. Damper vane should be able to move freely when debris is removed.
4. Recheck calibration using procedure in As-Found section.
5. If dual beam mechanical balance does not pass calibration, it will need to be replaced.

The following steps are to be performed as routine cleaning and maintenance of the electronic scales:

1. Check that weighing platform is level, clean, and free from vibration.
2. If electronic scale is out of tolerance, perform a calibration using the manufacturer's instruction manual and record results.
3. If electronic scale does not pass after calibration, it will need to be replaced.

## 6.3 As Left (post-maintenance check)

After performing the maintenance items listed in the previous section, the response of the balance/scale must be re-checked. If the instrument was not within the acceptance criteria prior to the maintenance, the pre-maintenance check can be repeated after the maintenance to determine if the operation was corrected by the routine maintenance procedures.

If the balance/scale response was within acceptance criteria, and passes the post-maintenance check described below, no adjustments are necessary.

1. Confirm that all questions on the Weighing Scales section of the data forms have been completed.
2. Ensure that dual beam balance is stored properly. Remove any load from the scale plate and place the slotted masses on the mass rack. Slide one of the poises away from the zero mark to make sure balance is not in equilibrium. This will keep the balance from oscillating and prevent unnecessary wear.

# 7.0 Troubleshooting

Reference the manuals listed in Section 5.0 if any additional troubleshooting of the balance/scale is required. Additional support may be obtained from the CAL instrument technicians.

# 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition for the performance surveys of the Ohaus balances will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections. The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the U.S. Environmental Protection Agency (EPA), the NADP Program Office (PO), and other data users.

## 8.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

### 8.1.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 1 shows this first screen.

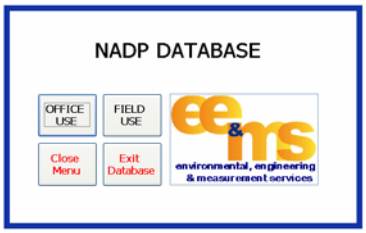



**Figure 1. User Type Selection Menu**

### 8.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 2 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data

- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

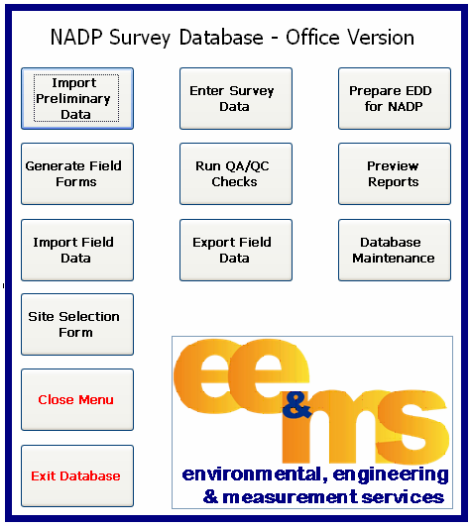



**Figure 2. NADP Survey Database – Office Version Main Menu**

### 8.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose form:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

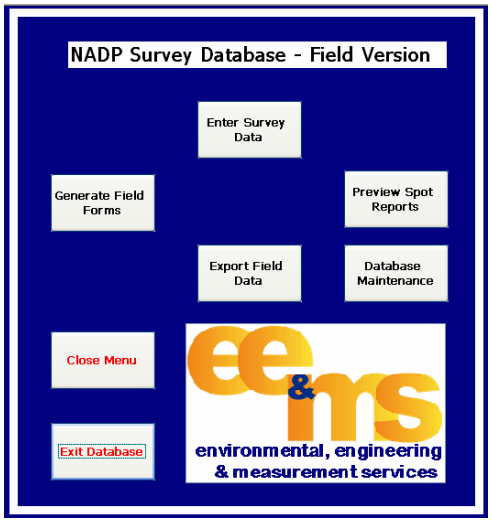



**Figure 3. NADP Survey Database – Field Version Main Menu**

### 8.1.4 Enter Survey Data

The Enter Survey Data menu (Figure 4) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form

- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

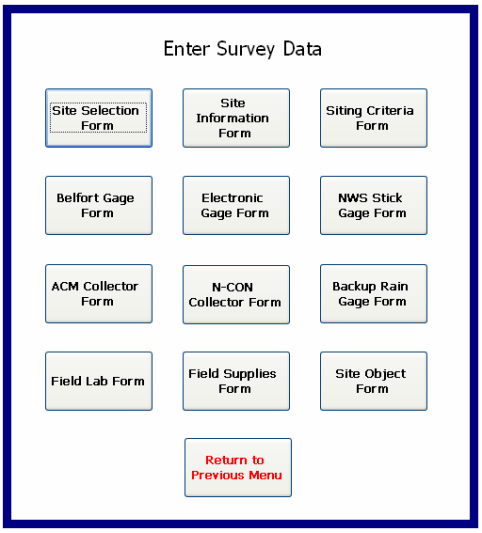



**Figure 4. Enter Survey Data Menu**

### 8.1.5 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 5 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

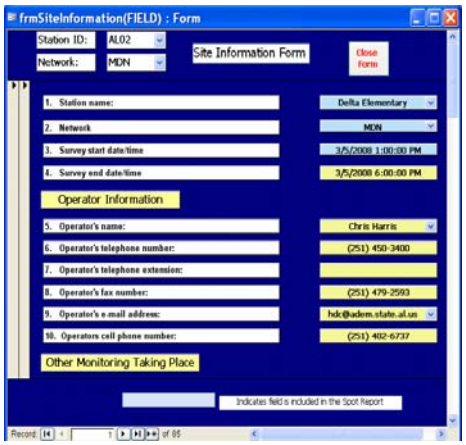



**Figure 5. Site Information Form (Field Form)**

### 8.1.6 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 6):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

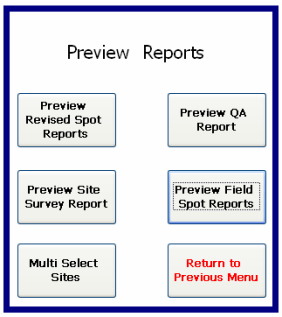



**Figure 6. Preview Reports Menu**

## 8.2 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.3 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.4 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

## 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

# 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data from Ohaus balances.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

## 9.1 Field Laptop Computer

The Survey Team Member will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

## 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.0 and subsections.

# 10.0 Data Management and Records Management

Data and records management procedures are presented in the Site Performance Survey SOPs for each network (SOP-EPW07061-1010, SOP-EPW07061-1020, SOP-EPW07061-1030)

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one quality assurance/quality control (QA/QC) role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Team Members are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for NADP Site Performance Survey procedures, but for all projects at EEMS

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Team Member.

Review and verification continue during the survey process. By requiring the Survey Team Member to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Team Member is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

### 11.2.1 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

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# Quality Assurance/Quality Control Documentation

| | |
|---|---|
| Title: | pH Meter Standard Operating Procedures (NADP INSTALLATIONS) |
| Document Number | SOP-EPW07061-1220 |
| Date: | September 2007 |

## Authorizations

| Title | Name | Affiliation | Signature |
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| Project Manager | Maria Jones | EEMS | Ma Luisa Repiso Jones |
| QA Manager | Keith Halbrook | EEMS | Charles Keith Hall |
| EPA Project Officer | | | |

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**List of Acronyms and Abbreviations**

| | |
|---|---|
| AIRMoN | Atmospheric Integrated Research Monitoring Network |
| ATS | Advance Technology Systems, Inc. |
| CAL | Central Analytical Laboratory |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| ISWS | Illinois State Water Survey |
| MDN | Mercury Deposition Network |
| NADP | National Atmospheric Deposition Program |
| NIST | National Institute of Standards and Technology |
| NTN | National Trends Network |
| PO | Program Office |
| QAPP | quality assurance project plan |
| SOP | standard operating procedure |

# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting performance surveys of the pH meters used at National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The pH meter is used at sites in the NADP Atmospheric Integrated Research Monitoring Network (AIRMoN) as part of the field laboratory activities that take place at these network sites.

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the NADP Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

The pH meter performance surveys include:

- Verifying that the instrument is capable of making valid and accurate measurements
- Challenging the probe with independent audit standard solutions (provided by CAL) to determine if the device is operating within defined project accuracy goals provided in the NADP QAPP
- Performing routine maintenance and/or minor repairs if necessary to return the instrument to operation within the designated specifications
- Subsequently re-challenging and/or retesting the instrument
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD)
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD
- Distributing the survey results, reports, and documentation to the designated project personnel

# 2.0 Summary of Methods

General methods used for performing a pH meter performance survey will include:

- Completing the "as found" or pre-maintenance challenge

- Recording the results of the pre-maintenance challenge
- Performing any required routine maintenance, calibration adjustment, or minor repair
- If required repeating the “as left” or post-maintenance challenge
- Recording the results of the additional challenge
- Entering the recorded data into the FSSD and backing up the files

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of NADP sites are addressed in the Site Performance Survey Standard Operating Procedures for each network (SOP-EPW07061-1010, SOP-EPW07061-1020, and SOP-EPW07061-1030).

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the NADP. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

The following tools and materials are required to conduct performance surveys of the pH meter:

- NADP operations manuals (AIRMoN)
- Site Survey File for the site

- Hardcopy forms (forms provided in Appendix A)
- pH probe calibration standard solutions
- Laptop computer with approved FSSD
- Miscellaneous recordkeeping supplies
- Miscellaneous cleaning supplies
- Manufacturer's instruction manuals

# 6.0 Instrument or Method Calibration and Standardization

The method described here was developed from tested and accepted procedures developed by the Central Analytical Laboratory (CAL) at Illinois State Water Survey (ISWS) and Advanced Technology Systems, Inc. (ATS). Refinements to the method will be incorporated as the NADP Site Survey Program goes forward.

## 6.1 As Found (pre-maintenance check)

The following steps are to be performed prior to conducting any instrument maintenance or adjustment to document the existing condition and operation of the pH probe

1. Check that probe was stored with electrode bulb wet, in proper storage solution. Note pH 4.01 buffer is an acceptable storage medium. The protective rubber cap or container filled with the buffer solution should be used for storage.
2. Check pH probe sensor for cracked or broken glass tip. Check cable and connector for good connection to meter. Check that probe is clean.
3. Rinse probe in deionized water and carefully shake water off probe. Note: do not wipe the probe electrode or the temperature probe as this may generate an electrostatic charge on the probe which can create measurement instability.
4. Insert probe into a clean container filled with pH 7.00 buffer. The end of the probe must be completely immersed into the buffer solution. Turn pH meter on. Stir the probes gently. Record pH buffer lot number and expiration date. Once the meter has stabilized, record the reading. Note: do not re-use buffer solution. Repeat the above step for pH buffer 4.01 and 10.00 and record readings, lot number and expiration date for each point.
5. If the pH meter reports the temperature measurement, use one of the above buffer check points to check temperature. Insert the temperature transfer standard in with pH probe. After stabilization, record and transfer standard reading and pH meter reading.
6. If pH system is within the acceptable limits for pH (± 0.15 of a pH of 4.9) and temperature as defined in the NADP QAPP, rinse probe in deionized water then store probe in proper storage solution and container.

### 6.2 Instrument Maintenance

Ensure that pH probe is stored, with electrode bulb wet, in the proper storage solution and container.

### 6.3 Calibration and Adjustment

After performing the maintenance items listed in the previous section, the response of the probe must be re-checked. If the probe was not within acceptance criteria prior to the maintenance, the pre-maintenance check can be repeated after the maintenance to determine if the operation has was corrected by the routine maintenance procedures.

- If the pH system is out of tolerance, perform a three point pH system calibration using the manufacturer's instruction manual and record results
- If the pH system does not pass calibration, it will need to be replaced. Notify the CAL as part of the site exit reporting process described in the AIRMoN Site Performance Survey Procedures (SOP-EPW-07061-1030)
- Confirm that all fields on the pH Meter Survey Data Form are complete
- Confirm that equipment has been returned to operational mode and is stored correctly

## 7.0 Troubleshooting

Reference the manuals listed in section 5.0 if any additional troubleshooting of the meter is required. Additional support may be obtained from the CAL instrument technicians.

## 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition for the performance surveys of the pH meter will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections. The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the U.S. Environmental Protection Agency (EPA), the NADP Program Office (PO), and other data users.

### 8.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided

in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

### 8.1.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 1 shows this first screen.

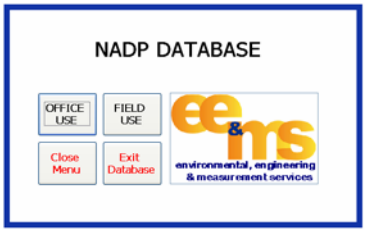



**Figure 1. User Type Selection Menu**

### 8.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 2 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

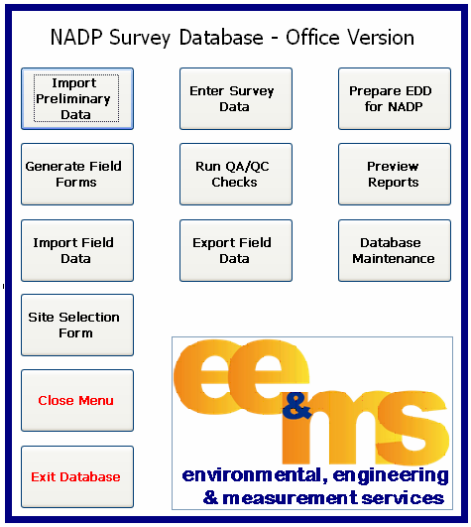



**Figure 2. NADP Survey Database – Office Version Main Menu**

### 8.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose form:

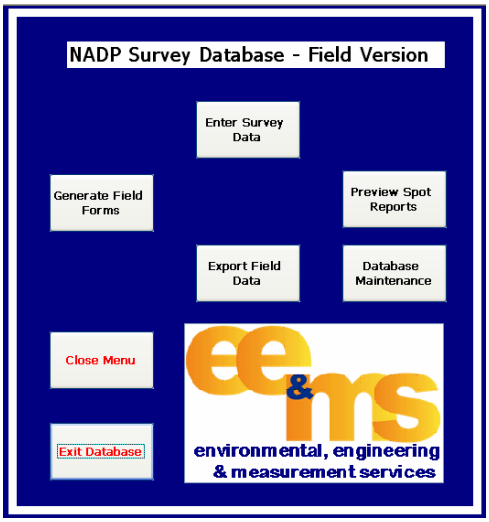



**Figure 3. NADP Survey Database – Field Version Main Menu**

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

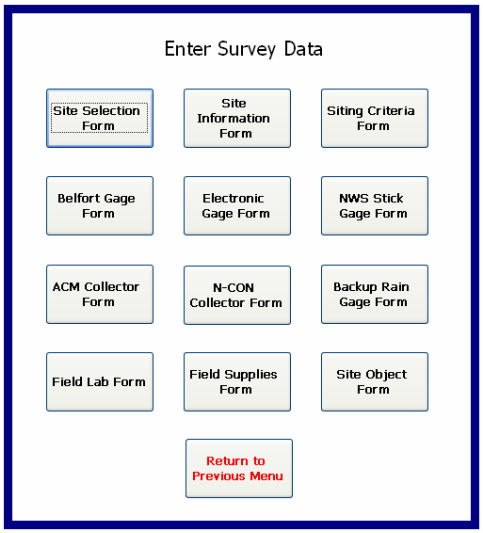



**Figure 4. Enter Survey Data Menu**

#### 8.1.3.1 Enter Survey Data

The Enter Survey Data menu (Figure 4) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form




**Figure 5. Site Information Form (Field Form)**

#### 8.1.4 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 5 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

### 8.1.5 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 6):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

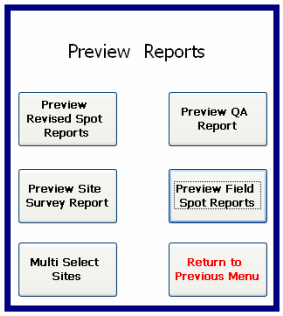



**Figure 6. Preview Reports Menu**

## 8.2 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.3 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.4 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

### 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

## 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data from the pH meter.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

### 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

### 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.0 and subsections.

## 10.0 Data Management and Records Management

Data and records management procedures are presented in the AIRMoN Site Performance Survey Standard Operating Procedures (SOP-EPW07061-1030).

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one quality assurance/quality control (QA/QC) role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for NTN Site Performance Survey procedures, but for all projects at EEMS.

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

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All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

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# Quality Assurance/Quality Control Documentation

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| Title: | Conductivity Meter Standard Operating Procedures (NADP INSTALLATIONS) |
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| Date: | September 2007 |

## Authorizations

| Title | Name | Affiliation | Signature |
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| QA Manager | Keith Halbrook | EEMS | Charles Keith Hallbrook |
| EPA Project Officer | | | |

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**List of Acronyms and Abbreviations**

| | |
|---|---|
| AIRMoN | Atmospheric Integrated Research Monitoring Network |
| ATS | Advance Technology Systems, Inc. |
| CAL | Central Analytical Laboratory |
| DI | deionized |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| ISWS | Illinois State Water Survey |
| NADP | National Atmospheric Deposition Program |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| SOP | standard operating procedure |
| SPSQ | Site Performance Survey Questionnaire |

# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting performance surveys of the conductivity meters located at National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The conductivity meter is used at sites in the NADP Atmospheric Integrated Research Monitoring Network (AIRMoN) as part of the field laboratory activities that take place at these network sites. It measures the conductivity of the precipitation collected after each precipitation event occurs.

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the NADP Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

The conductivity meter performance surveys include:

- Verifying that the instrument is capable of making valid and accurate measurements
- Challenging the instrument with independent audit standard solutions [provided by Central Analytical Laboratory (CAL)] to determine if the device is operating within defined project accuracy goals provided in the NADP QAPP
- Performing routine maintenance and/or minor repairs if necessary to return the instrument to operation within the designated specifications
- Subsequently re-challenging and/or retesting the instrument
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD)
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD
- Distributing the survey results, reports, and documentation to the designated project personnel

# 2.0 Summary of Methods

General methods used for performing a conductivity meter performance survey will include:

- Completing the “as found” or pre-maintenance challenge
- Recording the results of the pre-maintenance challenge
- Performing any required routine maintenance, calibration adjustment, or minor repair
- If required repeating the “as left” or post-maintenance challenge
- Recording the results of the additional challenge
- Entering the recorded data into the FSSD and backing up the files

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of AIRMoN NADP sites are addressed in the AIRMoN Site Performance Survey Standard Operating Procedures (SOP-EPW07061-1030).

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the NTN. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

The following tools and materials are required to conduct performance surveys of conductivity meters:

- NADP operations manuals (AIRMoN)

- Site Survey File for the site
- Hardcopy forms (forms provided in Appendix B)
- Conductivity calibration standard solutions
- Laptop computer with approved FSSD
- Miscellaneous recordkeeping supplies
- Miscellaneous cleaning supplies
- Manufacturer's instruction manuals

# 6.0 Instrument or Method Calibration and Standardization

The method described here was developed from tested and accepted procedures developed by the CAL at Illinois State Water Survey (ISWS) and Advanced Technology Systems, Inc. (ATS). Refinements to the method will be incorporated as the NADP Site Survey Program goes forward.

## 6.1 As Found (pre-maintenance check)

The following steps are to be performed prior to conducting any instrument maintenance or adjustment to document the existing condition and operation of the gauge:

1. Check that conductivity cell was stored properly:
   Short term: store conductivity cell in deionized (DI) water. Water must be changed frequently to prevent any growth that may cause cell to not function properly.
   Long term: Rinse cell with DI water and store dry. Cell should be soaked in DI water until cell tip appears black after storing dry.
2. Check conductivity cell for cracked or broken glass cell. Check cable and connector for good connection to meter. Check that cell is clean.
3. Turn meter on and verify that meter is properly setup according to the manufacturer’s manual.
4. Insert probe into a clean container filled with 1413µ/s solution. The end of the probe must be completely immersed into the buffer solution. Gently tap and stir the cell to remove any trapped air bubbles. Record conductivity solution lot number and expiration date on the form. Once the meter has stabilized, record the reading on the form. Rinse the conductivity cell with DI water, and gently shake water from cell. Note: do not re-use the conductivity solution.
5. Repeat the above step for conductivity solutions 447µ/s and 84µ/s and record the readings, lot number and expiration date for each point.

6. Use one of the above solution check points to check temperature. Insert the temperature transfer standard in with the conductivity cell. After stabilization, record and transfer standard reading and conductivity meter reading on the form.
7. If the conductivity system is within the acceptable limits as defined in the NADP QAPP for conductivity and temperature, rinse cell in DI or distilled water and then store the cell properly.

### 6.2 Instrument Maintenance

Conductivity cell cleaning:
Dip or fill conductivity cell with a foaming acidic tile cleaner, such as DOW Foaming Scrubbing Bubbles Bathroom Cleaner™ and agitate for two minutes, Remove the conductivity cell from cleaner and rinse in several changes of DI water.

### 6.3 Calibration and Adjustment

After performing the maintenance items listed in the previous section, the response of the conductivity meter must be re-checked. If the conductivity system is out of tolerance, perform a three point conductivity system calibration using the manufacturer's instruction manual and record the results on the form. If the conductivity system does not pass calibration, it will need to be replaced. Confirm that all questions on the conductivity Meter/Probe Survey Data Form are complete. Confirm that equipment has been returned to the "ready to sample" state and is stored correctly.

## 7.0 Troubleshooting

Reference the manuals listed in Section 5.0 if any additional troubleshooting of the meter is required. Additional support may be obtained from the CAL instrument technicians.

## 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition for the performance surveys of the conductivity meter will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections. The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the U.S. Environmental Protection Agency (EPA), the NADP Program Office (PO), and other data users.

## 8.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

### 8.1.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 1 shows this first screen.

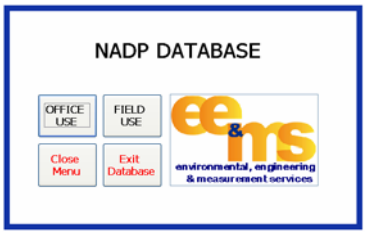



**Figure 1. User Type Selection Menu**

### 8.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 2 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

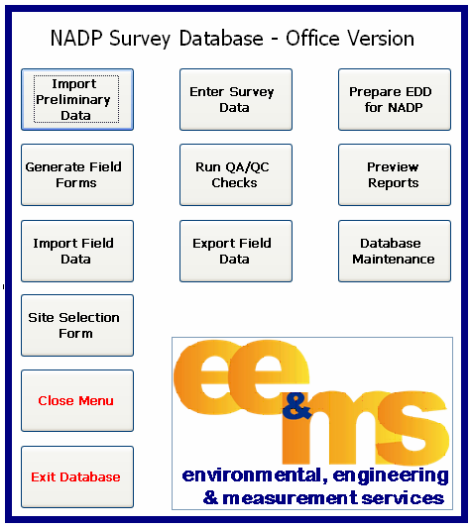



**Figure 2. NADP Survey Database – Office Version Main Menu**

### 8.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose form:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

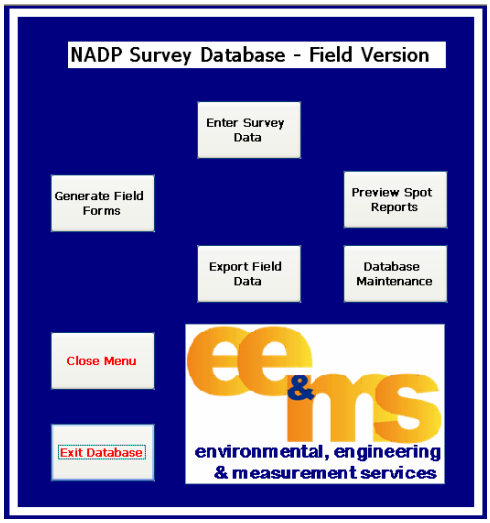



**Figure 3. NADP Survey Database – Field Version Main Menu**

#### 8.1.3.1 Enter Survey Data

The Enter Survey Data menu (Figure 4) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

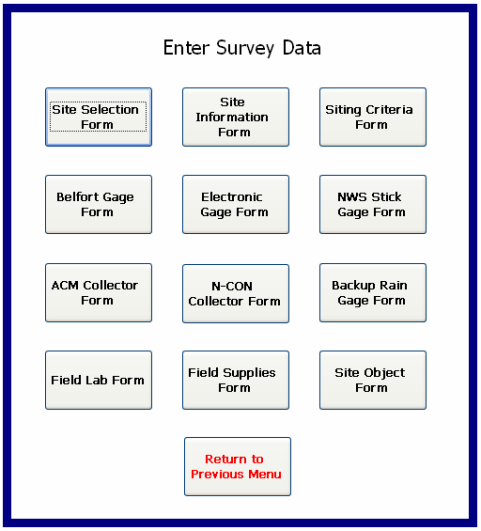



**Figure 4. Enter Survey Data Menu**

#### 8.1.4 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 5 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

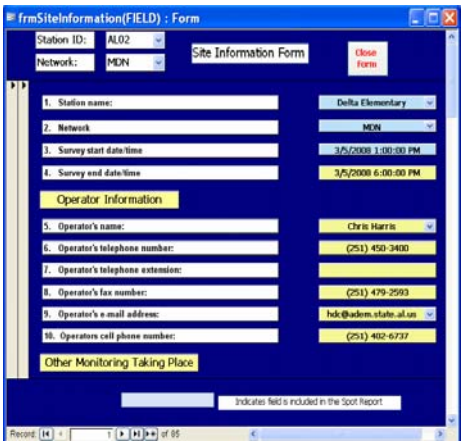



**Figure 5. Site Information Form (Field Form)**

### 8.1.5 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 6):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

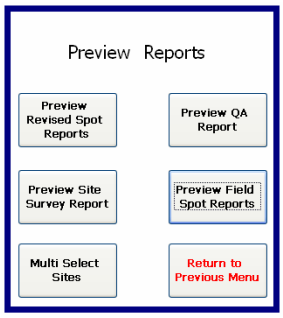



**Figure 6. Preview Reports Menu**

## 8.2 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.3 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.4 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

### 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

## 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data from the conductivity meter.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

### 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

### 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.0 and subsections.

## 10.0 Data Management and Records Management

Data and records management procedures are presented in the Site Performance Survey SOPs for each network (SOP-EPW07061-1010, SOP-EPW07061-1020, SOP-EPW07061-1030).

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one quality assurance/quality control (QA/QC) role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for NTN Site Performance Survey procedures, but for all projects at EEMS.

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

### 11.2.1 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

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# Quality Assurance/Quality Control Documentation

| | |
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| Title: | ACM NTN Precipitation Collector Standard Operating Procedures (NADP INSTALLATIONS) |
| Document Number | SOP-EPW07061-1310 |
| Date: | September 2007 |

## Authorizations

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| QA Manager | Keith Halbrook | EEMS | Charles Keith Hall |
| EPA Project Officer | | | |

## Revision History

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**List of Acronyms and Abbreviations**

| | |
|---|---|
| ATS | Advance Technology Systems, Inc. |
| CAL | Central Analytical Laboratory |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| ISWS | Illinois State Water Survey |
| NADP | National Atmospheric Deposition Program |
| NTN | National Trends Network |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| SOP | standard operating procedure |

# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting performance surveys of the ACM NTN Precipitation Collectors located at National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The ACM NTN Collector is used to collect the precipitation which occurs during each week of site operation.

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the NADP Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

ACM NTN Collector's performance surveys include:

- Verifying that the instrument is capable of collecting a valid, uncontaminated precipitation sample.
- Actuating the precipitation sensor to determine proper operation of the collector lid.
- Performing routine maintenance and/or minor repairs if necessary to return the collector to operation within the designated specifications.
- Subsequently re-challenging and/or retesting the collector.
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD).
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD.
- Distributing the survey results, reports, and documentation to the designated project personnel.

# 2.0 Summary of Methods

General methods used for performing an ACM NTN Collector's performance survey will include:

- Documenting the existing condition on the forms provided and with digital photographs,

- Completing the "as found" or pre-maintenance challenge,
- Recording the results of the pre-maintenance challenge,
- Performing any required routine maintenance, or minor repair,
- If required repeating the "as left" or post-maintenance challenge,
- Recording the results of the additional challenge,
- Entering the recorded data into the FSSD and backing up the files,

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of NADP sites are addressed in the Site Performance Survey SOP for NTN (SOP-EPW07061-1010).

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the NTN. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

The following tools and materials are required to conduct performance surveys of the AMC NTN Collector:

- NADP operations manuals (NTN)

- Site Survey File for the site
- Hardcopy data forms (forms provided in Appendix B)
- Belfort calibration weights
- Basic hand tools
- Level
- Zero residue cleaner and cleaning supplies
- Laptop computer with approved FSSD
- Miscellaneous recordkeeping supplies
- Manufacturer's instruction manuals

# 6.0 Instrument or Method Calibration and Standardization

The method described here was developed from tested and accepted procedures developed by the Central Analytical Laboratory (CAL) at Illinois State Water Survey (ISWS) and Advanced Technology Systems, Inc. (ATS). Refinements to the method will be incorporated as the NADP Site Survey Program goes forward.

## 6.1 As Found (pre-maintenance check)

The following steps are to be performed prior to conducting any instrument maintenance or adjustment to document the existing condition and operation of the collector:

1. Take pictures of the collector if necessary to document the condition.
2. Record the observations concerning the general collector condition and the installation per questions on the Site Survey Questionnaire.
3. Note and record the GPS location of the collector over the center of the wet collection bucket.
4. Put the clean lid on dry side bucket. Remove bucket from the collector and replace it with the test bucket.
5. Place a few drops of water on the rain sensor to move lid from the wet side to the dry side of the collector.
6. Put the clean lid on the wet side bucket. Remove the bucket from the collector and replace it with the test bucket.
7. Check to see that the lid seal is making sealing contact with the dry bucket rim and is clean.
8. Blow away any remaining moisture from the rain sensor to activate the lid so that it returns to the wet side.
9. Check to see that the lid seal is making sealing contact with the wet bucket rim.

10. Unplug the precipitation collector from the 120v power. Place a small amount of water on the grid to initiate the lid movement and see if it will operate properly under battery power only.
11. Load test the battery following these procedures:
    - Make sure the motorbox and/or charger is unplugged before load testing the battery.
    - Clip the red lead from tester to the positive post of the battery and the black lead to the negative post of the battery.
    - Determine the proper load test duration using for the battery size and the ambient temperature. Note: do not stand over the battery during the load test.
    - Test the battery for a determined duration. Watch the meter for battery condition. (It should remain in the "green" section of the meter indicator window.)
    - Remove load tester.
12. After the load test, plug motorbox and/or charger into the 120v power if applicable.
13. Perform the rain sensor heater test following these procedures:
    - Install the rain sensor test housing over the sensor.
    - Push the thermocouple sensor down to ensure a good contact with the sensor plate.
    - Plug the thermocouple into the meter and record the unheated surface temperature.
    - Remove the rain sensor test housing and install the grid shorting clip. The unit should move from the wet side to the dry side.
    - Reinstall the rain sensor test housing pushing the thermocouple down to ensure good contact with the sensor plate.
    - Record the sensor temperature at 2 min., 4 min., 6 min., 8 min., and 10 min. intervals.
    - The sensor temperature after 10 minutes should be approx. 50 ± 5 °C.
    - If the site is equipped with a Belfort precipitation gauge, check to ensure that the recording rain gauge event recorder pen is in the up position while rain sensor is shorted.
    - Remove the rain sensor test housing and the grid shorting clip. Note: the sensor should be warm to the touch and unit lid should move back to the wet side.
    - If the sensor fails the temperature test, replacement will be necessary.
14. Test clutch lift of collector performing the following procedures:
    - The unit lid should be on the wet side.
    - Place 2 Belfort calibration weights in the center of the unit lid.
    - Use the grid shorting clip to short the sensor grid and move the lid from the wet side to the dry side. Make note of the movement of the weighted lid. It should be able to move smoothly without disengaging.
    - Remove the grid shorting clip, lid should move back to the wet side.

- If the clutch fails the lift test, refer to Section 4.3 of the ACM Precipitation Collector Maintenance Manual for adjustment or replacement of the clutch mechanism.
- Re-test the clutch after repair.
- Remove the test weights.

### 6.2 Maintenance

1. Clean the sensor head to remove any debris that could cause the collector to open unnecessarily.
2. Straighten the sensor grids if bent.
3. Clean the battery terminals if needed and spray with protector.
4. Level and secure the collector to the base as needed.
5. Replace the lid seal if it is torn or not sealing properly.

### 6.3 Post-maintenance Checks

1. Confirm that all questions on the ACM NTN Precipitation Collector section of the "Site Survey Questionnaire" are complete.
2. Confirm that the measurement and collection equipment has been returned to the "ready to sample" state.

## 7.0 Troubleshooting

Reference the manuals listed in Section 5.0 if any additional troubleshooting of the collector is required. Additional support may be obtained from the CAL instrument technicians.

## 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition for the performance surveys of the ACM collector will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections. The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the U.S. Environmental Protection Agency (EPA), the NADP Program Office (PO), and other data users.

## 8.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

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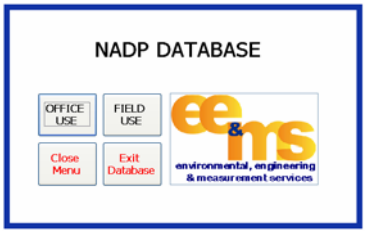



**Figure 1. User Type Selection Menu**

### 8.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 2 shows the different options the user can choose from:

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- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

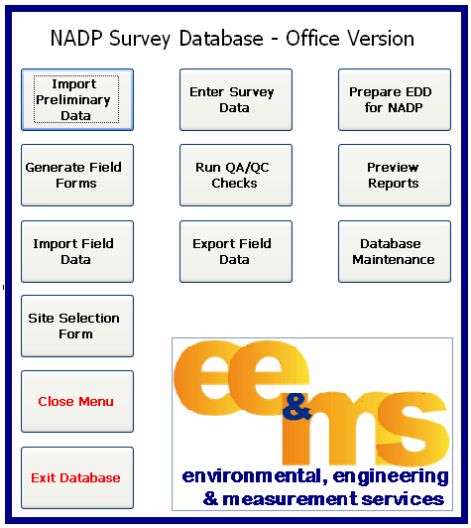



**Figure 2. NADP Survey Database – Office Version Main Menu**

### 8.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose form:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

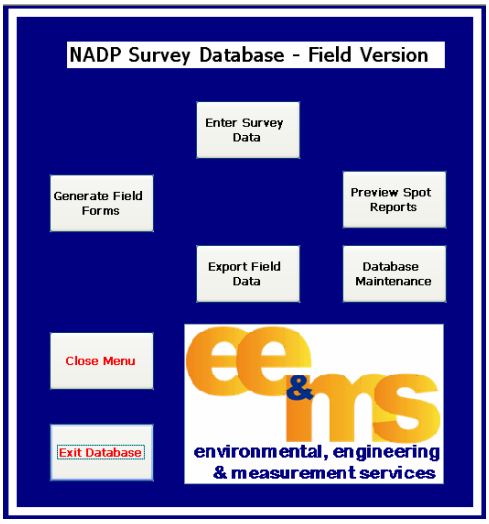



**Figure 3. NADP Survey Database – Field Version Main Menu**

#### 8.1.3.1 Enter Survey Data

The Enter Survey Data menu (Figure 4) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

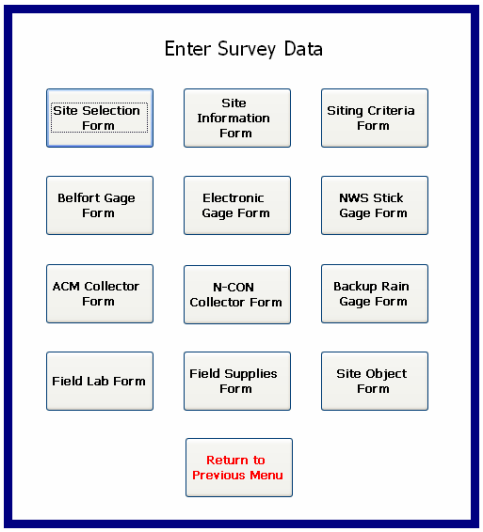



**Figure 4. Enter Survey Data Menu**

### 8.1.4 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 5 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

### 8.1.5 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 6):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

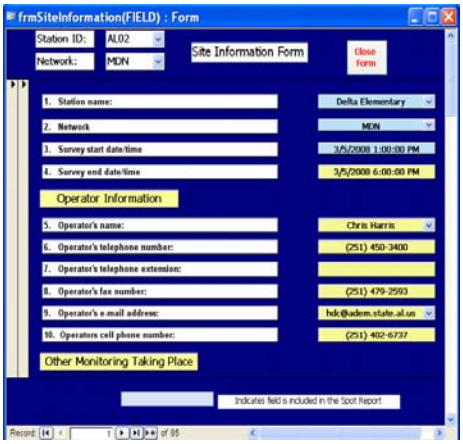



**Figure 5. Site Information Form (Field Form)**

## 8.2 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

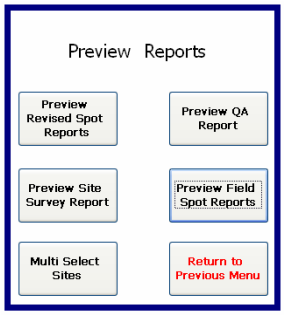



**Figure 6. Preview Reports Menu**

## 8.3 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.4 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

### 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

## 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data from the ACM NTN Precipitation Collector. Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

### 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

### 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.1 and subsections.

## 10.0 Data Management and Records Management

Data and records management procedures are presented in the Site Performance Survey SOPs for the NTN (SOP-EPW07061-1010).

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one quality assurance/quality control (QA/QC) role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for NTN Site Performance Survey procedures, but for all projects at EEMS

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

### 11.2.1 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

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# Quality Assurance/Quality Control Documentation

| | |
|---|---|
| Title: | ACM MDN Precipitation Collector Standard Operating Procedures (NADP INSTALLATIONS) |
| Document Number | SOP-EPW07061-1320 |
| Date: | October 2007 |

## Authorizations

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| EPA Project Officer | | | |

## Revision History

| Revision No. | Description | Date | Authorization |
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| 1 | Michael Kolian's comments | May 2008 | |
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**List of Acronyms and Abbreviations**

| | |
|---|---|
| ATS | Advance Technology Systems, Inc. |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| HAL | Mercury Analytical Laboratory |
| MDN | Mercury Deposition Network |
| NADP | National Atmospheric Deposition Program |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| SOP | standard operating procedure |

# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting performance surveys of the ACM MDN Precipitation Collectors located at National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The ACM MDN Precipitation Collector is used to collect the precipitation which occurs during each week of site operation.

The purpose of a performance survey is to assess the collector's field performance under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the precipitation collection process is operating within the project acceptance criteria as defined in the NADP Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

ACM MDN Precipitation Collector's performance surveys include:

- Verifying that the instrument is capable of collecting valid, uncontaminated precipitation samples.
- Actuating the precipitation sensor to determine proper operation of the collector lid.
- Performing routine maintenance and/or minor repairs if necessary to return the collector to operation within the designated specifications.
- Subsequently re-challenging and/or retesting the collector.
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD).
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD.
- Distributing the survey results, reports, and documentation to the designated project personnel.

# 2.0 Summary of Methods

General methods used for performing a ACM MDN Precipitation Collector performance survey will include:

- Documenting the existing condition on the forms provided and with digital photographs,
- Completing the "as found" or pre-maintenance challenge,
- Recording the results of the pre-maintenance challenge,
- Performing any required routine maintenance, or minor repair,
- If required repeating the "as left" or post-maintenance challenge,
- Recording the results of the additional challenge,
- Entering the recorded data into the FSSD and backing up the files.

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of MDN sites are addressed in the Site Performance Survey SOP (SOP-EPW07061-1020).

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the MDN. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

The following tools and materials are required to conduct performance surveys of the ACM MDN Precipitation Collector:

- NADP operations manuals (MDN)
- Site Survey File for the site
- Hardcopy data forms (forms provided in Appendix B)
- Belfort calibration weights
- Basic hand tools
- Level
- Zero residue cleaner and cleaning supplies
- Laptop computer with approved FSSD
- Miscellaneous recordkeeping supplies
- Manufacturer's instruction manuals

# 6.0 Instrument or Method Calibration and Standardization

The method described here was developed from tested and accepted procedures developed by the Mercury Analytical Laboratory (HAL) and Advanced Technology Systems, Inc. (ATS). Refinements to the method will be incorporated as the NADP Site Survey Program goes forward.

## 6.1 As Found (pre-maintenance check)

***Special Note on Mercury Collector Sensitivity:***

*It is very important to follow the MDN Project Specific SOP when working around the collector or handling samples from the collector. Dirt and other particles typically have mercury absorbed into their surfaces and if any of this material was to accidentally get into the sample bottle, it could significantly contaminate the sample.*

1. Approach the collector from downwind.
2. If the site operator is onsite, have them retrieve the samples (wet/dry) in accordance with the MDN Project Specific SOP and observe their techniques and record any observations. If the site operator is not present, retrieve the samples (wet/dry) in accordance with the MDN Project Specific SOP.
3. Take pictures of the collector from at least 2 from different angles.
4. Record any observations concerning the general condition of the collector and the installation per the questions on Site Survey Questionnaire.
5. Note and record the GPS location of the collector over the center of the unit.
6. Replace the dry side bucket with the test bucket.
7. Open the enclosure door and place a temperature transfer unit probe inside so that the probe is placed in an open airflow area. Close the door and let the temperature stabilize

before recording the reading. Open the door and quickly record the min/max thermometer reading. Is min/max reading within tolerance (± 10°F)? Record the results on the Site Survey Questionnaire.

8. If the temperature within the collector is out of acceptable range (40° to 100°F), record this finding on the Site Survey Questionnaire, and adjust the thermostat.
9. Place a few drops of water on the rain sensor to move lid from wet side to dry side of collector.
10. Check to see that the lid seal is making sealing contact with the dry bucket rim and is clean.
11. Blow away any remaining moisture from rain sensor to activate lid so that it returns to the wet side.

***Special Note Regarding Blowing Water Off the Rain Sensor***

*The step described above is very important. Your sample funnel is now open and exposed. If the operator was to blow the water off the sensor toward the open funnel, there is a great potential for contamination of the sample to occur. If the operator has fillings in their teeth, it is likely that their saliva has detectable concentrations of mercury. Dental fillings are mercury amalgams, and therefore have a significant amount of mercury in them. Further, there is potential to blow debris/particles toward the open funnel which could also cause contamination. Always blow the sensor off with your back to the open funnel.*

12. Check to see that the lid seal is making sealing contact with the wet funnel.
13. Unplug the precipitation collector from the 120v power, put a small amount of water on the grid to initiate the lid movement and see if it will operate properly under battery power only.
14. Load test the battery following these procedures:
    - Make sure the motorbox and/or charger are unplugged before load testing the battery.
    - Clip the red lead from tester to the positive post of the battery and the black lead to the negative post of the battery.
    - Determine the proper load test duration for the battery size and ambient temperature. Note: do not stand over the battery during the load test.
    - Test the battery for a determined duration. Watch the meter for battery condition. (It should remain in the “green” section of meter indicator window.)
    - Remove the load tester.
15. After completing the load test, plug the motorbox and/or charger into the 120v power if applicable.
16. Perform a rain sensor heater test following these procedures:
    - Install the rain sensor test housing over the sensor.

- Push the thermocouple sensor down to ensure good contact with the sensor plate.
- Plug the thermocouple into the meter and record the unheated surface temperature.
- Remove the rain sensor test housing and install the grid shorting clip. The unit should move from the wet side to the dry side.
- Reinstall the rain sensor test housing pushing the thermocouple down to ensure good contact with the sensor plate.
- Record the sensor temperature at 2 min., 4 min., 6 min., 8 min., and 10 min. intervals.
- The sensor temperature after 10 minutes should be approximately 50 ± 5 °C.
- If the site is equipped with a Belfort precipitation gauge check to ensure that the recording rain gauge event recorder pen is in the up position while rain sensor is shorted.
- Remove the rain sensor test housing and grid shorting clip. Note: the sensor should be warm to the touch and the unit lid should move back to the wet side.

17. Test the clutch lift of the collector performing the following procedures:
    - The unit lid should be on the wet side.
    - Place 2 Belfort calibration weights in the center of the unit lid.
    - Use the grid shorting clip to short the sensor grid and move the lid from the wet side to the dry side. Make a note of the movement of the weighted lid. It should be able to move smoothly without disengaging.
    - Remove the grid shorting clip, the lid should move back to the wet side.
    - If the clutch fails the lift test, refer to Section 4.3 of the ACM Precipitation Collector Maintenance Manual for the adjustment or the replacement of the clutch mechanism.
    - Re-test the clutch after repair.
    - Remove the test weights.

## 6.2 Maintenance

1. Clean the sensor head to remove any debris that could cause the collector to open unnecessarily.
2. Straighten the sensor grids if they appear bent.
3. Clean the battery terminals if needed and spray with protector.
4. Level and secure the collector to the base as needed.
5. Replace the lid seal if it is torn or not sealing properly.
6. Check the caulk around funnel chimney and re-caulk with Dow 100% silicone, if needed.
7. Check the sample bottle lab jack for smooth operation.

8. Check the sampler arm boots and replace if they are cracked or torn.
9. Check event recorder operation on Belfort (or other gauge used).

***Perform Event Recorder Operation Verification***
*Check to ensure that the Event Recorded was working when you had the MDN Collector open earlier in this procedure (when removing and deploying your glassware). You should see on the chart paper an ER pen spike at the end of the measuring period. The ER pen should have moved to the open or "Up" position during this time. It should have then returned to the closed or "Baseline" position signifying the lid was closed over the wet side of the collector.*

### 6.3 Post-maintenance Checks

1. Confirm that all questions and tests on the MDN Collector section of the "Site Survey Questionnaire" are complete.
2. Confirm that the measurement and collection equipment has been returned to it's "ready to sample" state.

## 7.0 Troubleshooting

Reference the manuals listed in Section 5.0 if any additional troubleshooting of the gauge is required. Additional support may be obtained from the HAL instrument technicians.

## 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition for the performance surveys of the ACM collector will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections. The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the U.S. Environmental Protection Agency (EPA), the NADP Program Office (PO), and other data users.

### 8.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

### 8.1.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 1 shows this first screen.

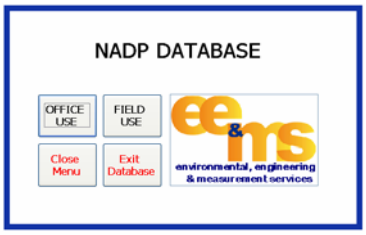



**Figure 1. User Type Selection Menu**

### 8.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 2 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

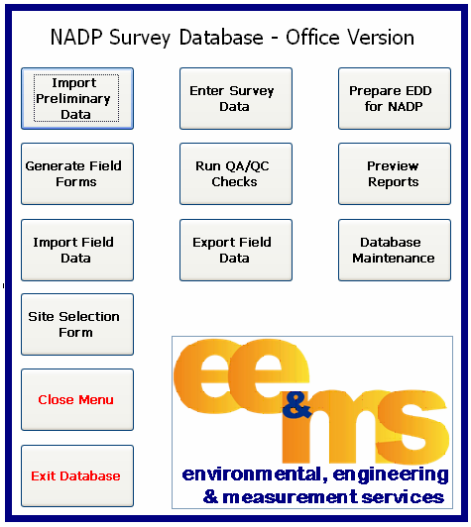



**Figure 2. NADP Survey Database – Office Version Main Menu**

### 8.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose form:

- Generate Field Forms
- Enter Survey Data

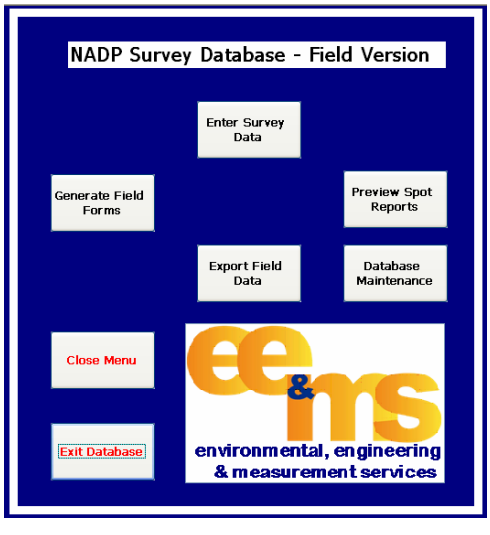



**Figure 3. NADP Survey Database – Field Version Main Menu**

- Export Field Data
- Preview Spot Report
- Database Maintenance

#### 8.1.3.1 Enter Survey Data

The Enter Survey Data menu (Figure 4) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

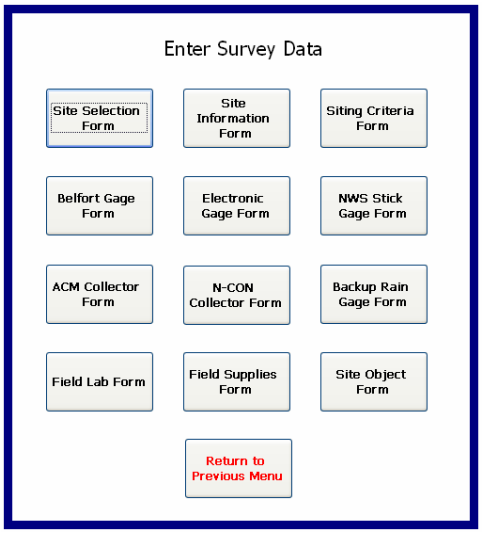



**Figure 4. Enter Survey Data Menu**

#### 8.1.4 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 5 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

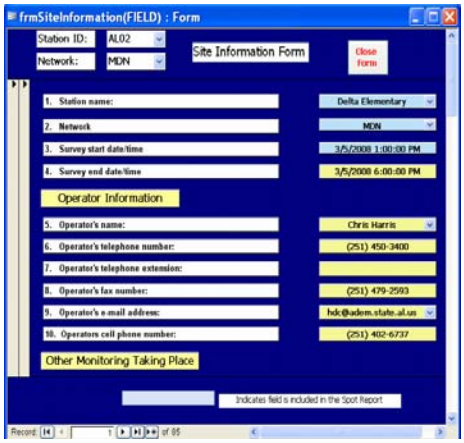



**Figure 5. Site Information Form (Field Form)**

#### 8.1.5 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 6):

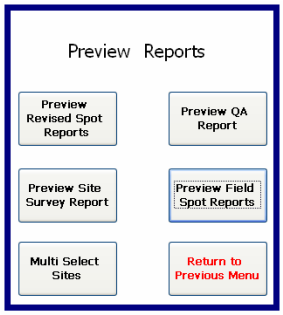



**Figure 6. Preview Reports Menu**

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

## 8.2 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.3 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.4 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

## 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are

highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

# 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data from the ACM MDN Precipitation Collector. Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

## 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

## 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.0 and subsections.

# 10.0 Data Management and Records Management

Data and records management procedures are presented in the Site Performance Survey SOP (SOP-EPW07061-1020).

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one quality assurance/quality control (QA/QC) role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for MDN Site Performance Survey procedures, but for all projects at EEMS

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

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All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will

report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

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It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

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# Quality Assurance/Quality Control Documentation

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| Document Number | SOP-EPW07061-1330 |
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## Authorizations

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| QA Manager | Keith Halbrook | EEMS | Charles Keith Hall |
| EPA Project Officer | | | |

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**List of Acronyms and Abbreviations**

| | |
|---|---|
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| MDN | Mercury Deposition Network |
| NADP | National Atmospheric Deposition Program |
| OPS | optical precipitation sensor |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| SOP | standard operating procedure |

# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting performance surveys of the N-CON MDN Precipitation Collector located at National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The N-CON MDN Precipitation Collector is used to collect the precipitation which occurs during each week of site operation.

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the NADP Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

The N-CON MDN Precipitation Collector performance surveys include:

- Verifying that the instrument is capable of collecting a valid, uncontaminated precipitation sample.
- Performing routine maintenance and/or minor repairs if necessary to return the collector to operation within the designated specifications.
- Subsequently re-challenging and/or retesting the collector.
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD).
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD.
- Distributing the survey results, reports, and documentation to the designated project personnel.

# 2.0 Summary of Methods

General methods used for performing a N-CON MDN Precipitation Collector performance survey will include:

- Documenting the existing condition on the forms provided and with digital photographs,

- Completing the “as found” or pre-maintenance challenge,
- Recording the results of the pre-maintenance challenge,
- Performing any required routine maintenance, calibration adjustment, or minor repair,
- If required repeating the “as left” or post-maintenance challenge,
- Recording the results of the additional challenge,
- Entering the recorded data into the FSSD and backing up the files.

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of NADP sites are addressed in the Site Performance Survey SOP for MDN (SOP-EPW07061-1020).

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the MDN. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

The following tools and materials are required to conduct performance surveys of the N-CON MDN Precipitation Collector:

- NADP operations manuals (MDN)

- Site Survey File for the site
- Hardcopy data forms (forms provided in Appendix B)
- Basic hand tools
- Level
- Zero residue cleaner and cleaning supplies
- Laptop computer with approved FSSD
- Miscellaneous recordkeeping supplies
- Manufacturer's instruction manuals

# 6.0 Instrument or Method Calibration and Standardization

The method described here was developed from tested and accepted procedures developed by the Mercury Analytical Laboratory (HAL). Refinements to the method will be incorporated as the NADP Site Survey Program goes forward.

## 6.1 As Found (pre-maintenance check)

***Special Note Mercury Collector Sensitivity:***
*It is very important to follow the MDN Project Specific SOP when working around the collector or handling samples from the collector. Dirt and other particles typically have mercury absorbed into their surfaces and if any of this material was to accidentally get into the sample bottle, it could significantly contaminate the sample.*

1. Approach the collector from downwind.
2. If a site operator is onsite, have him/her retrieve the sample in accordance with the FGS-MDN-001-NCON SOP, observe the technique used, and record the observations. If a site operator is not present, retrieve the sample in accordance with the FGS-MDN-001-NCON SOP.
3. Take pictures of the collector if necessary to document the condition.
4. Record the observations concerning general collector condition and installation per questions on the Site Survey Questionnaire.
5. Note and record the GPS location of the collector over the sample inlet.
6. Open the enclosure door and place the survey standard temperature probe inside so that the probe is placed in an open airflow area. Close the door and let the temperature stabilize and record the reading. Open the door and quickly record the min/max thermometer reading. The min/max reading should be within ± 10°F of the standard. Record the results on the Site Survey Questionnaire.

7. If the temperature within the collector is out of the acceptable range (40° to 100°F), record this on the Site Survey Questionnaire and adjust the thermostat.
8. Check to see that the lid seal is making sealing contact with the funnel rim and that it is clean.
9. Pass your hand through the optical precipitation sensor (OPS) to activate the collector lid. Note: unplug the power cord or use the power switch to stop the collector lid from closing, if needed.
10. Test the OPS using a spray bottle of water. Spray a mist through the path of the OPS to activate the collector lid. The lid should return to cover the funnel after a 2 minute no-mist or rain time.

### 6.2 Instrument Maintenance

1. Clean the optical precipitation sensor with wet paper towel.
2. Level and secure the collector to the base if needed.
3. Replace the lid seal if it is torn or not sealing properly.
4. Check the sample bottle turn tray for smooth operation.
5. Check the event recorder operation on the Belfort.

***Perform Event Recorder Operation Verification***

*Check to ensure that the Event Recorded was working when you had the MDN N-CON Collector open earlier in this procedure (when removing and deploying your glassware). You should see on the chart paper an ER pen spike at the end of the measuring period. The ER pen should have moved to the open or "Up" position during this time. It should have then returned to the closed or "Baseline" position signifying the lid was closed over the wet side of the collector.*

### 6.3 As Left (post-maintenance check)

1. Confirm that all the questions and tests on the MDN Collector section of the "Site Survey Questionnaire" are complete.
2. Confirm that the measurement and collection equipment has been returned to the "ready to sample" state.

## 7.0 Troubleshooting

Reference the manuals listed in Section 5.0 if any additional troubleshooting of the collector is required. Additional support may be obtained from the HAL instrument technicians.

# 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition for the performance surveys of the N-CON MDN Precipitation Collector will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections. The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the U.S. Environmental Protection Agency (EPA), the NADP Program Office (PO), and other data users.

## 8.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

### 8.1.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 1 shows this first screen.

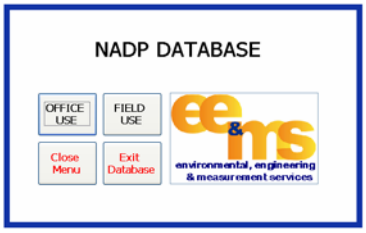



**Figure 1. User Type Selection Menu**

### 8.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 2 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data

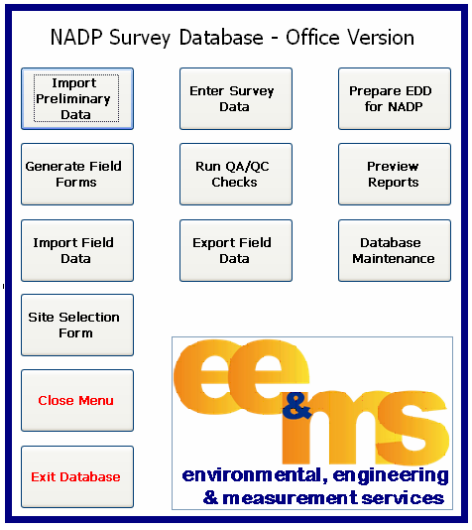



**Figure 2. NADP Survey Database – Office Version Main Menu**

- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

### 8.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose form:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

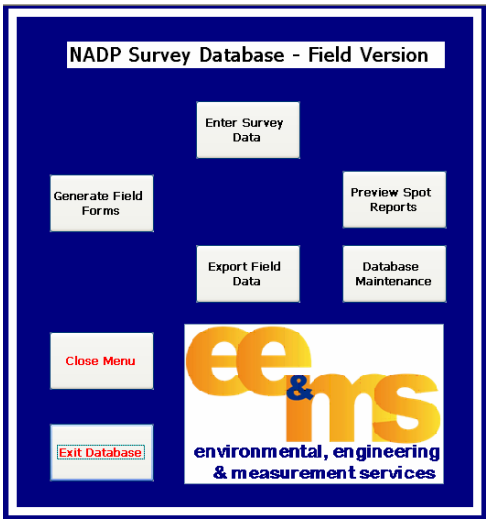



**Figure 3. NADP Survey Database – Field Version Main Menu**

#### 8.1.3.1 Enter Survey Data

The Enter Survey Data menu (Figure 4) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

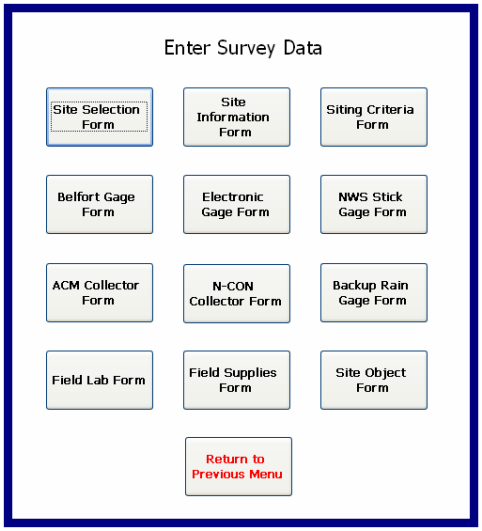



**Figure 4. Enter Survey Data Menu**

### 8.1.4 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 5 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.




**Figure 5. Site Information Form (Field Form)**

### 8.1.5 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 6):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

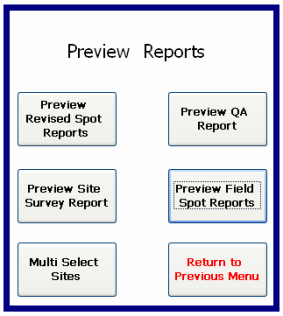



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| QA Manager | Keith Halbrook | EEMS | Charles Keith Hall |
| EPA Project Officer | | | |

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| | |
|---|---|
| ATS | Advance Technology Systems, Inc. |
| CAL | Central Analytical Laboratory |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| ISWS | Illinois State Water Survey |
| MDN | Mercury Deposition Network |
| NADP | National Atmospheric Deposition Program |
| NIST | National Institute of Standards and Technology |
| NTN | National Trends Network |
| PO | Program Office |
| QAPP | quality assurance project plan |
| SOP | standard operating procedure |

# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting performance surveys of the Belfort 5-780 Precipitation Gauges located at National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The Belfort 5-780 Recording Rain (precipitation) Gauge is used to continuously measure the amount of precipitation by weight which occurs during each week of site operation. The amount is recorded to a hardcopy chart located within the gauge.

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the NADP Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

Belfort 5-780 gauge performance surveys include:

- Verifying that the instrument is capable of making valid and accurate measurements.
- Challenging the gauge with an independent audit standard [traceable to National Institute of Standards and Technology (NIST) or other authoritative standard] to determine if the device is operating within defined project accuracy goals provided in the NADP QAPP.
- Performing routine maintenance and/or minor repairs if necessary to return the gauge to operation within the designated specifications.
- Subsequently re-challenging and/or retesting the gauge.
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD).
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD.
- Distributing the survey results, reports, and documentation to the designated project personnel.

# 2.0 Summary of Methods

General methods used for performing a Belfort gauge performance survey will include:

- Documenting the existing condition on the forms provided and with digital photographs,
- Completing the "as found" or pre-maintenance challenge,
- Recording the results of the pre-maintenance challenge,
- Performing any required routine maintenance, calibration adjustment, or minor repair,
- If required repeating the "as left" or post-maintenance challenge,
- Recording the results of the additional challenge,
- Entering the recorded data into the FSSD and backing up the files,

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of NADP sites are addressed in the Site Performance Survey SOPs for each network (SOP-EPW07061-1010, SOP-EPW07061-1020, SOP-EPW07061-1030)

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the NTN and MDN. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

The following tools and materials are required to conduct performance surveys of Belfort gauges:

- NADP operations manuals (NTN, MDN)
- Site Survey File for the site
- Hardcopy data forms (forms provided in Appendix B)
- Belfort standard calibration weights (12)
- Belfort linearity tool (2)
- Belfort pen arm bracket support tool
- Belfort bucket equivalent weight
- Basic hand tools
- Level
- Zero residue cleaner and cleaning supplies
- Laptop computer with approved FSSD
- Miscellaneous recordkeeping supplies
- Manufacturer's instruction manuals
- NADP Belfort Rain Audit Check Calibration document (CAL)

# 6.0 Instrument or Method Calibration and Standardization

The method described here was developed from tested and accepted procedures developed by the Central Analytical Laboratory (CAL) at Illinois State Water Survey (ISWS) and Advanced Technology Systems, Inc. (ATS). Refinements to the method will be incorporated as the NADP Site Survey Program goes forward.

## 6.1 As Found (pre-maintenance check)

The following steps are to be performed prior to conducting any instrument maintenance or adjustment to document the existing condition and operation of the gauge:

1. Document the condition of the gauge on the provided forms and with digital photographs if necessary.
2. Mark the chart by gently rocking the drum or moving the pen arm to make a cross on the recorded trace. Remove the chart and notate with the data and time of the survey and initial.
3. Compare the chart time with actual time. The NADP criterion is ± 6 hours.
4. Install a new chart documented with the site ID, “pre-maintenance check”, time and date of the survey, and Survey Technician name.

5. Remove wind shields, gauge housing, and bucket to gain access to the instrument.
6. Install the bucket equivalent weight onto the bucket platform washer.
7. Gently rock and advance the chart drum slightly (or move the pen) to record the zero (bucket equivalent weight) on the chart.
8. Gently add Belfort standard weights (one through twelve) one at a time and gently rock and advance the chart slightly (or move the pen) to record the response from each.
9. Advance the chart to a new position.
10. Gently remove Belfort standard weights (twelve through one) one at a time and gently rock and advance the chart slightly (or move the pen) to record the response from each.
11. Engage the pen shifter and remove the drum and chart for data acquisition and analysis.
12. Remove the bucket equivalent weight.

## 6.2 Read and Record the Gauge Response

Unless otherwise noted, each Belfort standard weight should increase the pen response by 1.00 inch. Evaluate the gauge response and record the data on the Belfort Survey Data Form (included in Appendix B).

The NADP acceptance criterion is 1.00 inch response per weight ± 0.10 inch. If the responses recorded are within criteria then only cleaning and maintenance are required. The chart drive (drum clock) criterion is ± six hours from the actual time. If the clock time is not within the criterion it may need to be replaced.

## 6.3 Instrument Maintenance

The following steps are to be performed as routine cleaning and maintenance of the Belfort gauge:

1. Check and re-level the gauge by placing the level on the Bucket Platform Washer and adjusting the gauge as necessary.
2. If pens are not recording properly, clean with alcohol and adjust the tension of the contact with the chart.
3. Clean any debris and dirt from the gauge and mechanical movement.
4. Check for and remove corrosion or anything that causes excessive friction or “stickiness” of the mechanism. Only zero residue cleaner and cleaning supplies (soft brush, paper towel) can be used to clean the mechanism.
5. Replace any loose or missing locking screws or parts.
6. Check the orientation of the event marker pens, the NTN pen should be the upper pen, MDN should be the lower.

7. Remove the red "zero-adjust" knob and replace with a stainless-steel cap screw and locking nut.
8. Check and fill the dashpot reservoir with silicone oil to a level just slightly above the piston when in the upper-most position.

## 6.4 As Left (post-maintenance check)

After performing the maintenance items listed in the previous section, the response of the gauge must be re-checked. If the gauge was not within acceptance criteria prior to the maintenance, the pre-maintenance check can be repeated after the maintenance to determine if the operation has was corrected by the routine maintenance procedures.

If the gauge response was within acceptance criteria, and passes the post-maintenance check described below, no adjustments are necessary.

1. Reinstall the chart used for the pre-maintenance check and advance to a new position. Document the position as "post-maintenance"
2. Using the technique described in section 6.1 check four gauge responses. (0, 3, 6, 9 inches)
3. If the gauge passed the pre-maintenance check and the post-maintenance check, remove the calibration chart and return the sample chart.
4. Reinstall all items removed for the survey and maintenance to the proper operating condition.

## 6.5 Calibration and Adjustment

If the gauge was not within acceptance criteria when checked and maintenance activities did not return it to proper operating condition, then calibration adjustments are required. The following steps are to be performed for the calibration of the gauge:

1. Remove the event recorder.
2. Reinstall the bucket platform.
3. Back-out the limit screws to allow the mechanism to move through the full range.
4. Center the screws and nuts in the slot lengths of each lever extension.
5. Check Spring plate; parallel to frame. (Allen cap screw) (fine adjustment)
6. Apply bucket equivalent weight & 3 Belfort standard weights
7. Install pen arm bracket stand-off tool and adjust pen arm to 3" mark
8. Install 2-calibration linearity tool over copper screw head on Z and straight link and adjust so linearity tool will fit over copper screws, tighten screws, then remove all three adjustment tools. Pen arm will move either up or down

9. Readjust pen arm to 3” by spring arm knob (gray or brass colored course knob). To move the pen arm down adjust clockwise, to move the pen arm up adjust counter-clockwise.
10. Install weights 1-6, note placement of pen arm, should grow 1” per weight.
11. If pen arm grows LESS than 1” move first traverse extension OUT (lengthen)
12. If pen arm grows MORE than 1” move link IN (shorten)
13. Check cross over at the top of the 6” line (6 weights)
14. Adjust crossover by turning screw on Z-LINK (small increments)
    - If pen arm is over the 6” mark (by lightly pushing up and down on platform) adjust Z-LINK screw CW.
    - If pen arm is under the 6” mark (by lightly pushing up and down on platform) adjust Z-LINK screw CCW
15. Continue adding Weights 6-12 and watch pen arm travel 1” per weight
16. Adjust Extension Arm on Z-LINK as necessary
    - Move extension arm OUT to Grow (lengthen)
    - Move extension arm IN to Decrease (shorten)
17. After calibration of Rain Gauge reinstall event recorder.
18. Check both pen arms for clearance on movement and adjust if needed

If by removing 6 weights and the Pen Arm will not go to Zero, even by adjusting the Spring Knob, and still won’t adjust to Zero. Check Crossover and adjust.

(NOTE): Some gauges will go in and out of calibration as weights are applied

(NOTE): If the pen arm falls behind or ahead consistent with each weight on 6-12” then one must move the long lever up or down few graduation and recheck. This in turn will take the crossover out of adjustment, and then you have to readjust the crossover and recheck. Then start the process all over again 1-6”/6-12”. Make adjustments as needed.

## 7.0 Troubleshooting

Reference the manuals listed in section 5.0 if any additional troubleshooting of the gauge is required. Additional support may be obtained from the CAL instrument technicians.

## 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition for the performance surveys of Belfort precipitation gauges will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections. The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the

U.S. Environmental Protection Agency (EPA), the NADP Program Office (PO), and other data users.

## 8.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

### 8.1.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 1 shows this first screen.

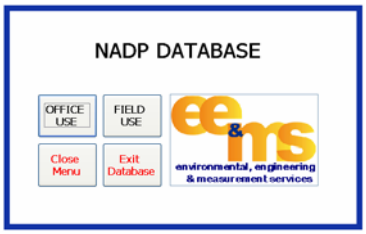



**Figure 1. User Type Selection Menu**

### 8.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 2 shows the different options the user can choose form:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

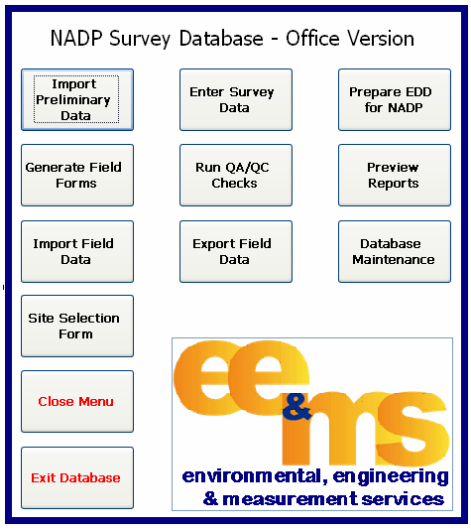



**Figure 2. NADP Survey Database – Office Version Main Menu**

### 8.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose from:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

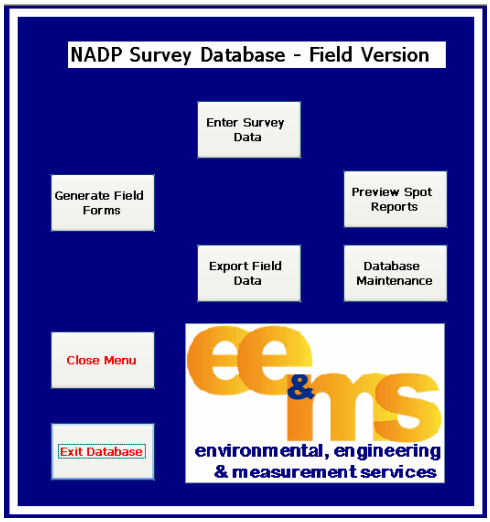



**Figure 3. NADP Survey Database – Field Version Main Menu**

#### 8.1.3.1 Enter Survey Data

The Enter Survey Data menu (Figure 4) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

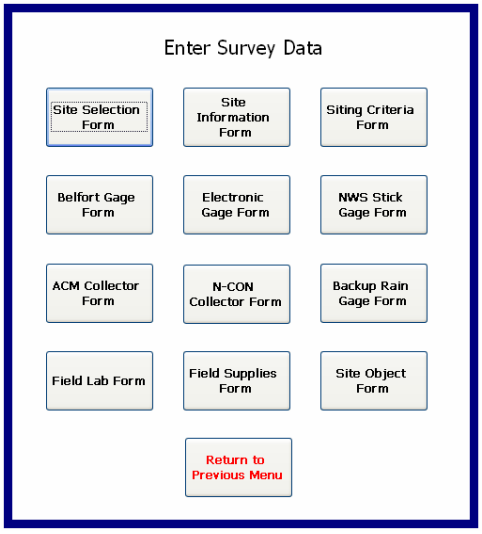



**Figure 4. Enter Survey Data Menu**

### 8.1.4 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 5 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this

form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

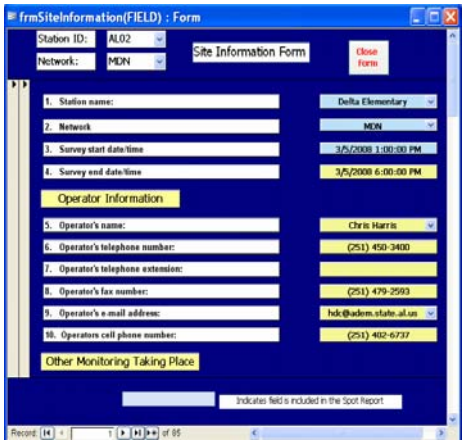



**Figure 5. Site Information Form (Field Form)**

### 8.1.5 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 6):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

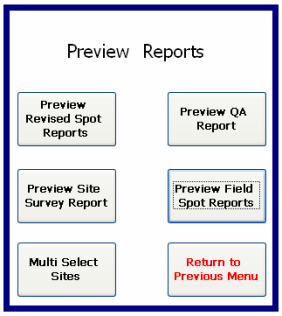



**Figure 6. Preview Reports Menu**

## 8.2 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.3 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

### 8.4 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

### 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

## 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data from Belfort precipitation gauges.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

### 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

### 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.1 and subsections.

# 10.0 Data Management and Records Management

Data and records management procedures are presented in the Site Performance Survey SOPs for each network (SOP-EPW07061-1010, SOP-EPW07061-1020, SOP-EPW07061-1030)

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one quality assurance/quality control (QA/QC) role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for NTN Site Performance Survey procedures, but for all projects at EEMS

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

### 11.2.1 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

environmental, engineering & measurement services

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# Quality Assurance/Quality Control Documentation

| | |
|---|---|
| Title: | OTT NADP Pluvio Electronic Precipitation Gauge Standard Operating Procedures (NADP INSTALLATIONS) |
| Document Number | SOP-EPW07061-1410 |
| Date: | October 2007 |

## Authorizations

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| Project Manager | Maria Jones | EEMS | Ma Luisa Repiso Jones |
| QA Manager | Keith Halbrook | EEMS | Charles Keith Hall |
| EPA Project Officer | | | |

## Revision History

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| 1 | Michael Kolians'n comments | May 2008 | |
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**List of Acronyms and Abbreviations**

| | |
|---|---|
| CAL | Central Analytical Laboratory |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| ISWS | Illinois State Water Survey |
| MDN | Mercury Deposition Network |
| NADP | National Atmospheric Deposition Program |
| NIST | National Institute of Standards and Technology |
| NTN | National Trends Network |
| PDA | Personal Digital Assistant |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| SOP | standard operating procedure |

# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting performance surveys of the OTT NADP Pluvio Electronic Precipitation Gauges located at National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The OTT NADP Pluvio Electronic Precipitation Gauge is used to continuously measure the amount of precipitation by weight which occurs during each week of site operation. The amount is recorded to an internal Campbell Scientific datalogger (DAS).

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the NADP Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

OTT NADP Pluvio Electronic Precipitation Gauge performance surveys include:

- Verifying that the instrument is capable of making valid and accurate measurements.
- Challenging the gauge with an independent audit standard [traceable to National Institute of Standards and Technology (NIST) or other authoritative standard] to determine if the device is operating within defined project accuracy goals provided in the NADP QAPP.
- Performing routine maintenance and/or minor repairs if necessary to return the gauge to operation within the designated specifications.
- Subsequently re-challenging and/or retesting the gauge.
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD).
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD.
- Distributing the survey results, reports, and documentation to the designated project personnel.

# 2.0 Summary of Methods

General methods used for performing an OTT NADP Pluvio Electronic Precipitation Gauge performance survey will include:

- Documenting the existing condition on the forms provided and with digital photographs if necessary,
- Completing the "as found" or pre-maintenance challenge,
- Recording the results of the pre-maintenance challenge,
- Performing any required routine maintenance, calibration adjustment, or minor repair,
- If required repeating the "as left" or post-maintenance challenge,
- Recording the results of the additional challenge,
- Entering the recorded data into the FSSD and backing up the files,

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of NADP sites are addressed in the Site Performance Survey SOPs for each network (SOP-EPW07061-1010, and SOP-EPW07061-1020)

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the NADP. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

The following tools and materials are required to conduct performance surveys of OTT NADP Pluvio Electronic Precipitation Gauge:

- NADP operations manuals (NTN, MDN)
- Site Survey File for the site
- Hardcopy data forms (forms provided in Appendix B)
- Calibration weights (6)
- Basic hand tools
- Level
- Zero residue cleaner and cleaning supplies
- Laptop computer with approved FSSD
- Miscellaneous recordkeeping supplies
- Manufacturer's instruction manuals

# 6.0 Instrument or Method Calibration and Standardization

The method described here was developed from tested and accepted procedures developed by the Central Analytical Laboratory (CAL) at Illinois State Water Survey (ISWS). Refinements to the method will be incorporated as the NADP Site Survey Program goes forward.

## 6.1 As Found (pre-maintenance check)

The following steps are to be performed prior to conducting any instrument maintenance or adjustment to document the existing condition and operation of the gauge:

1. Take pictures of Rain Gauge if necessary to document the condition of the gauge.
2. Record observations concerning general precipitation gauge condition and installation.
3. If a wind shield is present and prevents access to the gauge, remove wind shield.
4. Check level of precipitation gauge using a bubble level across inlet of collector funnel at perpendicular angles and record.
5. Measure and record funnel opening size and distance from ground to top of precipitation gauge.
6. During the winter season, check for winterization of precipitation gauge, record findings.
7. Note if any insects or insect nests are present in or on precipitation gauge.
8. Establish wireless communication with precipitation gauge using Pocket PC and Service/Audit Program.
9. Record date and time showing on precipitation gauge.
10. Note if evidence of precipitation is in precipitation gauge; document current reading.

11. Remove pipe house from precipitation gauge, note whether or not the pipe house is mounted correctly and damage-free.
12. Determine whether or not “housing off” switch will be recognized in the new software.
13. Note any insect activity, corrosion, or debris visible inside the pipe house. Photograph if necessary to document actual condition.
14. Inspect base and weighing mechanism.
15. Read bull’s-eye level at base of unit to determine if unit is sitting level.
16. Note if the moving part of weighing mechanism is in contact with the stationary parts.
17. Are transverse bars of the weighing mechanism deformed?
18. Note if collection bucket is deformed.
19. Note if the collection bucket is unstable on the black bucket support.
20. Remove the collection bucket, clean bucket and reinstall bucket in gauge; wait 90 seconds; document a zero reading.

## 6.2 Read and Record the Gauge Response

1. Carefully place the appropriate weight to simulate 0.25 inch of precipitation in bucket and wait 90 seconds before recording the reading. Repeat for 0.50 inch, 1 inch, 2 inches, 6 inches, and 10 inches simulated precipitation, recording each reading after 90 second wait time.
2. Repeat the process from highest to lowest weight, recording each reading until the final 0.25 inch reading is completed. Record bucket zero again when complete.
3. If the gauge is equipped with precipitation collector lid-position recording capabilities, test the event recording by simulating wet conditions on the precipitation collector. Note that the event is being recorded by precipitation gauge.

## 6.3 Instrument Maintenance

The following steps are to be performed as routine cleaning and maintenance of the OTT NADP Pluvio Electronic Precipitation Gauge:

1. Clean all moving parts and base with a soft brush, and canned air, being very careful not to damage the strain gauge.
2. Correct the level of precipitation gauge, if needed, by adjusting the bottom screws on the OTT NADP Pluvio Electronic Precipitation Gauge so that the air bubble appears in the marked ring of the bull’s-eye level.
3. Take the voltage reading on the back-up of the battery with the precipitation gauge plugged into the power source. Record the reading. Un-plug the gauge from the power source, and wait 3 minutes before taking a voltage reading on back-up battery. Record the voltage reading. Plug the precipitation gauge back into the power source.

4. If voltage reading is below 11.5 volts, note battery replacement needed on Site Survey Questionnaire.

### 6.4 Calibration and Post-maintenance Checks

1. Carefully reinstall the collection bucket and the precipitation gauge pipe housing.
2. Record the time of pipe housing reinstallation.
3. Record the zero weight of the collection bucket after 90 seconds.
4. Carefully place the appropriate weight to simulate 0.25 inch of precipitation in the bucket. Wait 90 seconds before recording the reading. Repeat the procedure for 0.50, 1, 2, 6, and 10 inches simulated precipitation. Record each reading after a 90 second wait time.
5. Repeat the process from the highest to the lowest weights recording each reading until the final 0.25 inch reading is completed. Record bucket zero again when complete.
6. If unit was winterized, re-winterize the collection bucket and record the weight reading.
7. Record the time when the unit post-check is complete.
8. Exit the wireless communications with the precipitation gauge.
9. Confirm that all questions on the OTT NADP Pluvio Electronic Precipitation Gauge Section of the "Site Survey Questionnaire" are complete.

## 7.0 Troubleshooting

Reference the manuals listed in Section 5.0 if any additional troubleshooting of the gauge is required. Additional support may be obtained from the CAL instrument technicians.

## 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition for the performance surveys of OTT NADP Pluvio Electronic Precipitation Gauge will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections. The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the U.S. Environmental Protection Agency (EPA), the NADP Program Office (PO), and other data users.

### 8.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered

into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

### 8.1.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 1 shows this first screen.

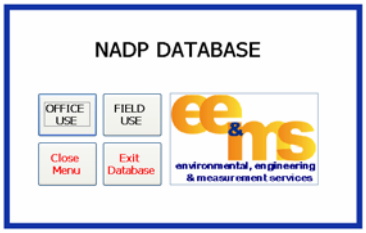



**Figure 1. User Type Selection Menu**

### 8.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 2 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

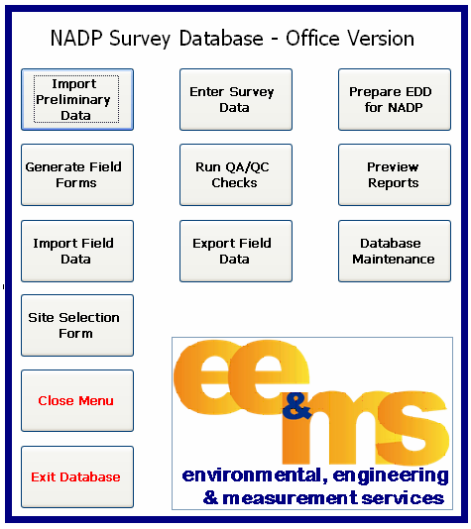



**Figure 2. NADP Survey Database – Office Version Main Menu**

### 8.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose

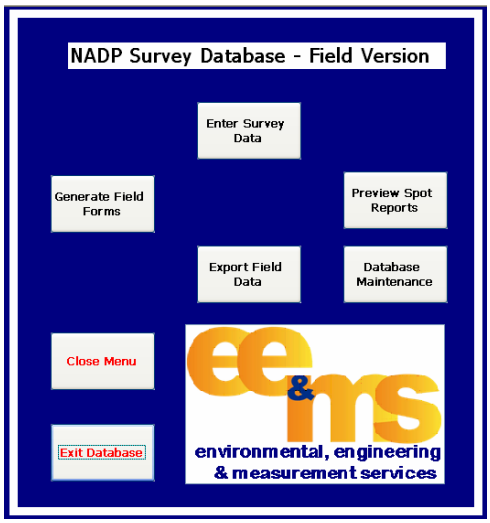



**Figure 3. NADP Survey Database – Field Version Main Menu**

from:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

#### 8.1.3.1 Enter Survey Data

The Enter Survey Data menu (Figure 4) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

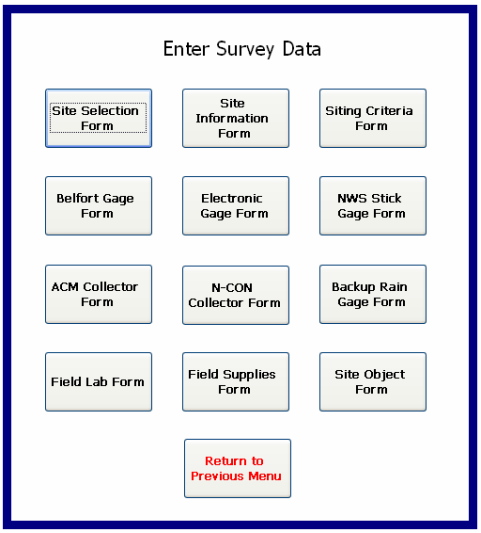



**Figure 4. Enter Survey Data Menu**

#### 8.1.4 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 5 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

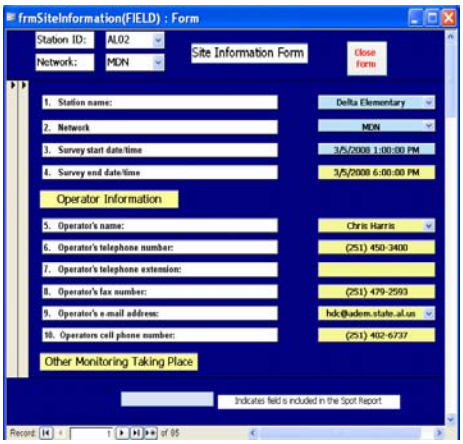



**Figure 5. Site Information Form (Field Form)**

### 8.1.5 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 6):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

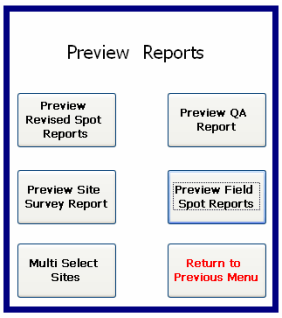



**Figure 6. Preview Reports Menu**

## 8.2 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.3 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.4 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

### 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

## 9.0 Computer Hardware and Software

Data recorded by the internal DAS is transferred to a Personal Digital Assistant (PDA) maintained by the site operator. The procedures used for the transfer and the integrity of the transferred data will be verified during the site systems survey.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

### 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

### 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSAD which will be the database used to manage the survey results. The FSAD and examples of the types of forms and screens have been discussed in Section 8.0 and subsections.

## 10.0 Data Management and Records Management

Data and records management procedures are presented in the Site Performance Survey SOPs for each network (SOP-EPW07061-1010, SOP-EPW07061-1020, and SOP-EPW07061-1030).

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one quality assurance/quality control (QA/QC) role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for NTN Site Performance Survey procedures, but for all projects at EEMS

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSAD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.
If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

## 11.3 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

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# Quality Assurance/Quality Control Documentation

| | |
|---|---|
| Title: | ETI NOAH IV Precipitation Gauge Standard Operating Procedures (NADP INSTALLATIONS) |
| Document Number | SOP-EPW07061-1420 |
| Date: | October 2007 |

## Authorizations

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| EPA Project Officer | | | |

## Revision History

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## List of Acronyms and Abbreviations

| | |
|---|---|
| CAL | Central Analytical Laboratory |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| ISWS | Illinois State Water Survey |
| MDN | Mercury Deposition Network |
| NADP | National Atmospheric Deposition Program |
| NIST | National Institute of Standards and Technology |
| NTN | National Trends Network |
| PDA | Personal Digital Assistant |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| SOP | standard operating procedure |

# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting performance surveys of the ETI NOAH IV Precipitation Gauges located at National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The ETI NOAH IV Precipitation Gauge is used to continuously measure the amount of precipitation by weight which occurs during each week of site operation. The amount is recorded on an internal Campbell Scientific datalogger (DAS).

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the NADP Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

The ETI NOAH IV Precipitation Gauge performance surveys include:

- Verifying that the instrument is capable of making valid and accurate measurements
- Challenging the gauge with an independent audit standard [traceable to National Institute of Standards and Technology (NIST) or other authoritative standard] to determine if the device is operating within defined project accuracy goals provided in the NADP QAPP
- Performing routine maintenance and/or minor repairs if necessary to return the gauge to operation within the designated specifications
- Subsequently re-challenging and/or retesting the gauge
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD)
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD
- Distributing the survey results, reports, and documentation to the designated project personnel

# 2.0 Summary of Methods

General methods used for performing a ETI NOAH IV Precipitation Gauge performance survey will include:

- Documenting the existing condition on the forms provided and with digital photographs if necessary
- Completing the “as found” or pre-maintenance challenge
- Recording the results of the pre-maintenance challenge
- Performing any required routine maintenance, calibration adjustment, or minor repair
- If required repeating the “as left” or post-maintenance challenge
- Recording the results of the additional challenge
- Entering the recorded data into the FSSD and backing up the files

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of NADP sites are addressed in the Site Performance Survey SOPs for each network (SOP-EPW07061-1010, SOP-EPW07061-1020, and SOP-EPW07061-1030).

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the NADP. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

The following tools and materials are required to conduct performance surveys of ETI NOAH IV Precipitation Gauges:

- NADP operations manuals (NTN, MDN)
- Site Survey File for the site
- Hardcopy data forms (forms provided in Appendix B)
- Standard calibration weights (6)
- Basic hand tools
- Level
- Zero residue cleaner and cleaning supplies
- Laptop computer with approved FSSD
- Miscellaneous recordkeeping supplies
- Manufacturer's instruction manuals

# 6.0 Instrument or Method Calibration and Standardization

The method described here was developed from tested and accepted procedures developed by the Central Analytical Laboratory (CAL) at Illinois State Water Survey (ISWS). Refinements to the method will be incorporated as the NADP Site Survey Program goes forward.

## 6.1 As Found (pre-maintenance check)

The following steps are to be performed prior to conducting any instrument maintenance or adjustment to document the existing condition and operation of the gauge:

1. Take pictures of ETI NOAH IV Precipitation Gauge if required to document the condition.
2. Record any observations concerning general ETI NOAH IV Precipitation Gauge condition and installation.
3. Remove the wind shield, if one is present and prevents access to the ETI NOAH IV Precipitation Gauge.
4. Check the level of ETI NOAH IV Precipitation Gauge using a bubble level across the inlet of the collector funnel at perpendicular angles. Record findings.
5. Measure and record the funnel opening size and the distance from the ground to top of the ETI NOAH IV Precipitation Gauge
6. During the winter season, check for winterization of ETI NOAH IV Precipitation Gauge, and record findings.

7. Note if any insects or insect nests are inside or on the ETI NOAH IV Precipitation Gauge. Pay special attention to the optical sensors in the funnel.
8. Establish a wireless communication with ETI NOAH IV Precipitation Gauge using Pocket PC and the Service/Audit Program.
9. Record the date and time shown on the ETI NOAH IV Precipitation Gauge.
10. Note if there is evidence of precipitation in the ETI NOAH IV Precipitation Gauge; document current reading.
11. Remove the inlet orifice from top of the ETI NOAH IV Precipitation Gauge, and inspect the o-ring.
12. Carefully lift out the collection chamber, being very careful not to drop chamber onto the weighing platform (this could damage the load cell).
13. Disconnect the two optics cables from their receptacles in the load plate by pulling on the connector and not the cable itself.
14. Remove the gauge housing from the base by loosening the three screws at the bottom of the housing that secures it to the base plate. Take care ***not*** to hold the gauge housing by the black emitters and detectors when removing the outer housing from the gauge base.
15. Note the condition of o-ring, and any insect activity, corrosion, or debris visible inside the gauge housing. Photograph if necessary to document the actual condition.
16. Inspect the base and weighing mechanism.
17. Note if the collection chamber is deformed.
18. Clean the collection chamber and reinstall the chamber in the gauge. Wait 90 seconds before documenting a zero reading.
19. Carefully place the appropriate weight to simulate 0.25inch of precipitation in the bucket. Wait 90 seconds before recording the reading.
20. Repeat the procedure for 0.50, 1, 2, 6, and 10 inches simulated precipitation, recording each reading after a 90-second wait time. Repeat the process from highest weight to lowest, recording each reading until you complete the final 0.25 inch reading. Record chamber zero again when complete.
21. If the ETI NOAH IV Precipitation Gauge is equipped with a precipitation collector lid-position recording capabilities, test event recording by simulating wet conditions on the precipitation collector. Note that the event is being recorded by ETI NOAH IV Precipitation Gauge.

## 6.2 Instrument Maintenance

The following steps are to be performed as routine cleaning and maintenance of the ETI NOAH IV Precipitation Gauge:

1. Clean all parts and base with a soft brush, and canned air, being very careful not to damage the load cell.

2. Take voltage reading on the back-up battery with the ETI NOAH IV Precipitation Gauge plugged in to the power source, and record the reading. Un-plug the gauge from the power source and wait 3 minutes before taking a voltage reading on the back-up battery. Record the reading before plugging the gauge back into the power source.
3. If the voltage reading is below 11.5 volts, note on the Site Survey Questionnaire that a battery replacement is needed.

## 6.3 Calibration and Post-maintenance Checks

1. Carefully reinstall the ETI NOAH IV Precipitation Gauge outer housing by placing the outer housing over the base assembly and carefully sliding it down to the base plate. Align the outer housing by matching the blue alignment dot on the inside of the gauge housing to the blue alignment dot on the top plate of the base assembly.
2. Reconnect the two optical sensor cables to their appropriate connectors in the load plate.
3. Reinstall the collection chamber by inserting it carefully down into the gauge housing and gently onto the platform. ***Make sure the chamber is not dropped onto the platform. This could cause irreversible damage to the load cell.***
4. Record the time of reinstallation of the ETI NOAH IV Precipitation Gauge outer housing, optical sensor cables, and collection chamber.
5. If the ETI NOAH IV Precipitation Gauge was found to be un-level during pre-calibration inspection, level the gauge.
6. Record the zero weight of collection chamber 90 seconds after reinstallation.
7. Carefully place the appropriate weight to simulate 0.25 inch of precipitation in the bucket, and wait 90 seconds. Record the reading. Repeat the procedure for 0.50, 1, 2, 6, and 10 inches of simulated precipitation. Recording each reading after a 90-second wait period. Repeat the process from the highest weight to the lowest, recording each reading until you complete the final 0.25 inch reading. Record the chamber zero again when complete.
8. If the unit was winterized, re-winterize the collection bucket and record the weight reading.
9. Record the time the post-check of the unit is completed.
10. Exit the wireless communications with the ETI NOAH IV Precipitation Gauge.
11. Confirm that all questions on the ETI NOAH IV Precipitation Gauge section of the “Site Survey Questionnaire” are complete.

# 7.0 Troubleshooting

Reference the manuals listed in Section 5.0 if any additional troubleshooting of the gauge is required. Additional support may be obtained from the CAL instrument technicians.

# 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition for the performance surveys of the ETI NOAH IV Precipitation Gauge will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections. The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the U.S. Environmental Protection Agency (EPA), the NADP Program Office (PO), and other data users.

## 8.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

### 8.1.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either office personnel or field personnel to the corresponding forms, function and repots. Figure 1 shows this first screen.

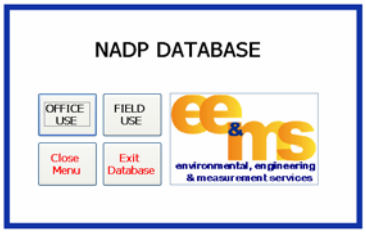



**Figure 1. User Type Selection Menu**

### 8.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 2 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form

- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

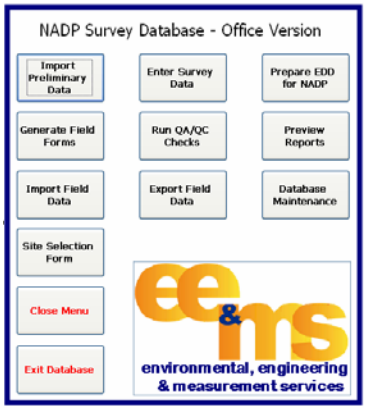



**Figure 2. NADP Survey Database – Office Version Main Menu**

### 8.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose form:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

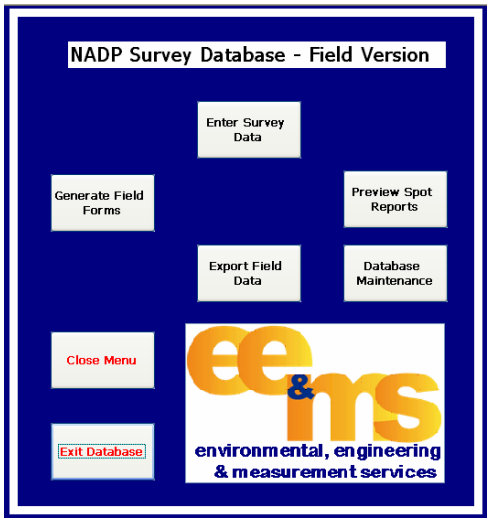



**Figure 3. NADP Survey Database – Field Version Main Menu**

#### 8.1.3.1 Enter Survey Data

The Enter Survey Data menu (Figure 4) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form

- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

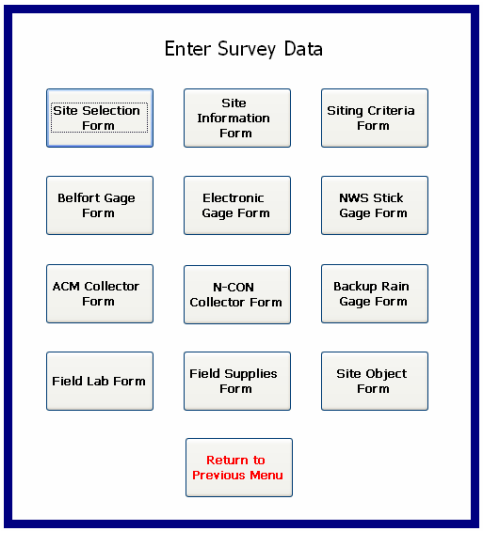



**Figure 4. Enter Survey Data Menu**

### 8.1.4 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 5 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

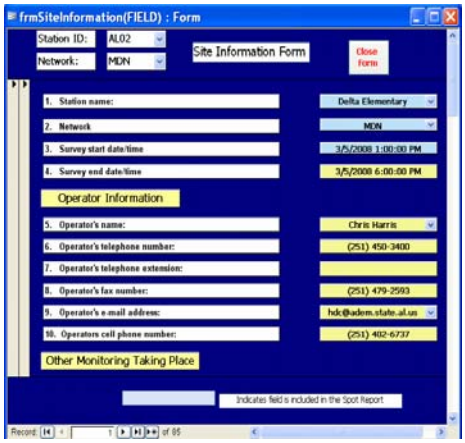



**Figure 5. Site Information Form (Field Form)**

### 8.1.5 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 6):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

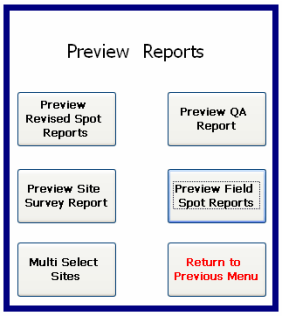



**Figure 6. Preview Reports Menu**

## 8.2 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.3 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.4 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

## 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

# 9.0 Computer Hardware and Software

Data recorded by the internal DAS is transferred to a Personal Digital Assistant (PDA) maintained by the site operator. The procedures used for the transfer and the integrity of the transferred data will be verified during the site systems survey.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

## 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

## 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.0 and subsections.

# 10.0 Data Management and Records Management

Data and records management procedures are presented in the Site Performance Survey SOPs for each network (SOP-EPW07061-1010, and SOP-EPW07061-1020).

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one quality assurance/quality control (QA/QC) role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and

dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for NTN Site Performance Survey procedures, but for all projects at EEMS

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project

Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

### 11.2.1 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

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# Quality Assurance/Quality Control Documentation

| | |
|---|---|
| Title: | NWS Stick Precipitation Gauge Standard Operating Procedures (NADP INSTALLATIONS) |
| Document Number | SOP-EPW07061-1430 |
| Date: | September 2007 |

## Authorizations

| Title | Name | Affiliation | Signature |
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| QA Manager | Keith Halbrook | EEMS | Charles Keith Hallbrook |
| EPA Project Officer | | | |

## Revision History

| Revision No. | Description | Date | Authorization |
|---|---|---|---|
| 0 | | Sept 2007 | |
| 1 | Michael Kolian's comments | May 2008 | |
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**List of Acronyms and Abbreviations**

| | |
|---|---|
| AIRMoN | Atmospheric Integrated Research Network |
| ATS | Advance Technology Systems, Inc. |
| CAL | Central Analytical Laboratory |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |
| ISWS | Illinois State Water Survey |
| NADP | National Atmospheric Deposition Program |
| NWS | National Weather Service |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| SOP | standard operating procedure |

# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting performance surveys of the NWS Stick Precipitation Gauges located at National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The NWS Stick Precipitation Gauge is used to measure the amount of precipitation which occurs during each sample day. The amount of precipitation is measured by introducing a prescribed stick into the gauge can and reading and recording the precipitation level.

The purpose of a performance survey is to assess the field measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance survey results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the NADP Quality Assurance Project Plan (QAPP). Proper implementation of a survey (or audit) program will ensure data integrity and assess data accuracy.

NWS Stick Precipitation Gauge performance surveys include:

- Verifying that the instrument is capable of making valid and accurate measurements
- Challenging the gauge with a known, and accurately measured volume of water, then measuring the depth of water in the can with the prescribed stick to determine if the stick is measuring the depth of water within defined project accuracy goals provided in the NADP QAPP
- Performing routine maintenance and/or minor repairs if necessary to return the gauge to operation within the designated specifications
- Subsequently re-challenging and/or retesting the gauge
- Documenting the survey results and activities (pre and post-maintenance) using the appropriate form(s) and Field Site Survey Database (FSSD)
- Documenting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD
- Distributing the survey results, reports, and documentation to the designated project personnel

# 2.0 Summary of Methods

General methods used for performing a NWS Stick Precipitation Gauge performance survey will include:

- Documenting the existing condition on the forms provided and if necessary with digital photographs
- Completing the "as found" or pre-maintenance challenge
- Recording the results of the pre-maintenance challenge
- Performing any required routine maintenance
- Repeating the "as left" or post-maintenance challenge
- Recording the results of the additional challenge
- Entering the recorded data into the FSSD and backing up the files

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of NADP sites are addressed in the Site Performance Survey SOP for each network (SOP-EPW07061-1010, SOP-EPW07061-1020, SOP-EPW07061-1030).

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gauges, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use at NADP sites. Procedures for testing and challenging any new equipment will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

The following tools and materials are required to conduct performance surveys of NWS Stick Precipitation Gauges:

- NADP operations manual (AIRMoN)
- Site Survey File for the site
- Hardcopy data forms (forms provided in Appendix B)
- Volumetric flask (accurately measured volume of water)
- Caliper
- Laptop computer with approved FSSD
- Miscellaneous recordkeeping supplies
- Miscellaneous cleaning supplies
- Manufacturer's instruction manuals

# 6.0 Instrument or Method Calibration and Standardization

The method described here was developed from tested and accepted procedures developed by the Central Analytical Laboratory (CAL) at Illinois State Water Survey (ISWS) and Advanced Technology Systems, Inc. (ATS). Refinements to the method will be incorporated as the NADP Site Survey Program goes forward.

## 6.1 As Found (pre-maintenance check)

The following steps are to be performed prior to conducting any instrument maintenance or adjustment to document the existing condition and operation of the gauge:

1. Take digital photographs, if necessary to document condition of gauge.
2. Note if evidence of precipitation is in Stick Gauge; document current reading
3. Check 45° rule for inlet and record if violated
4. Note if objects greater than one meter in height are inside the 5 meter radius.
5. Record what type of rain gauge shield is installed at site (“none”, “Alter”, or “other”).
6. Check level of Stick Gauge using a bubble level across inlet of collector funnel at perpendicular angles and record.
7. Measure diameter of the inlet and record.
8. Introduce two know volumes of water into the gauge collection can. Record the reading on measurement stick.
9. Perform the can leak-test by setting the can on a paper towel and observing for wetness.

10. Check stability of Stick Gauge and record.
11. Record observations concerning general Stick Gauge condition and installation.
12. Record distance from ground to top of gauge.
13. Record if gauge is on a “stand on” platform.
14. Record distance from collector (and vertical distance between inlets) to Stick Gauge.

### 6.2 Instrument Maintenance

The following steps are to be performed as routine cleaning and maintenance of the NWS Stick Precipitation Gauge:

1. Empty and clean Stick Gauge collection can and measuring stick.
2. If Stick Gauge is unstable, secure gauge to base.
3. If Stick Gauge is un-level, level gauge.

### 6.3 As Left (post-maintenance check)

After performing the maintenance items listed in the previous section, the response of the gauge must be re-checked. If the gauge was not within acceptance criteria prior to the maintenance, the pre-maintenance check can be repeated after the maintenance to determine if the operation has was corrected by the routine maintenance procedures. The post-maintenance performance checks are:

1. Introduce two know volumes of water into the gauge collection can. Record the reading on measurement stick.
2. Confirm that all fields on the Stick Gauge Survey Data Form are complete.
3. Confirm that measurement and collection equipment has been returned to operation mode.

Do not make any adjustments to the stick or the stick gauge.

## 7.0 Troubleshooting

Reference the manuals listed in Section 5.0 if any additional troubleshooting of the gauge is required. Additional support may be obtained from the CAL instrument technicians.

# 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition for the performance surveys of NWS Stick Precipitation Gauges will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections. The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the U.S. Environmental Protection Agency (EPA), the NADP Program Office (PO), and other data users.

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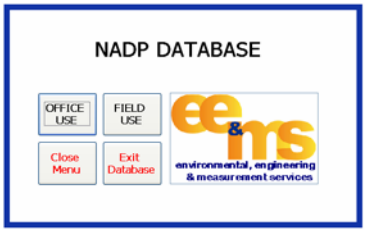



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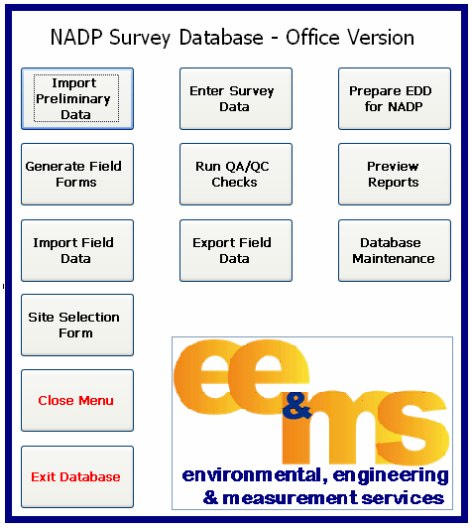



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- Preview Reports
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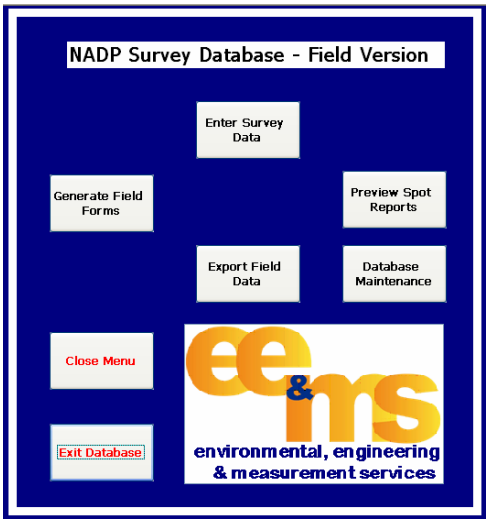



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The Enter Survey Data menu (Figure 4) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

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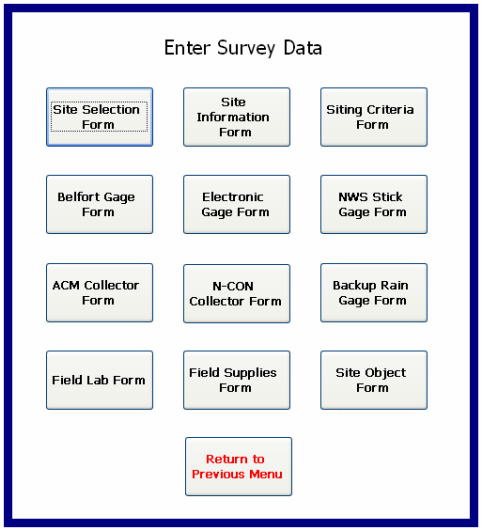



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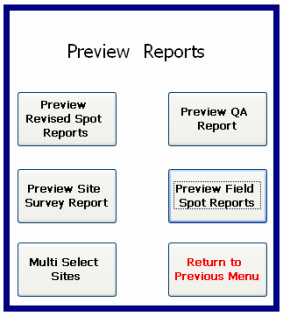



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### 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

## 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data from NWS Stick Precipitation Gauge.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

### 9.1 Field Laptop Computer

The Survey Technician will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

### 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.0 and subsections.

## 10.0 Data Management and Records Management

Data and records management procedures are presented in the AIRMoN Site Performance Survey Standard Operating Procedures (SOP-EPW07061-1030).

## 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one quality assurance/quality control (QA/QC) role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Technicians are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following sections describe the quality process that is not only employed for NADP Site Performance Survey procedures, but for all projects at EEMS

### 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Technician.

Review and verification continue during the survey process. By requiring the Survey Technician to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Technician is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This begins with the review of the documentation as described and the incorporating of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

### 11.2.1 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

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# Quality Assurance/Quality Control Documentation

| | |
|---|---|
| Title: | NADP Site Systems Survey Standard Operating Procedures (NADP INSTALLATIONS) |
| Document Number | SOP-EPW07061-1500 |
| Date: | September 2007 |

## Authorizations

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**List of Acronyms and Abbreviations**

| | |
|---|---|
| AIRMoN | Atmospheric Integrated Research Monitoring Network |
| CAL | Central Analytical Laboratory |
| CD | compact disc |
| DAS | data acquisition system |
| DCN | document control number |
| EDD | electronic data delivery |
| EEMS | Environmental Engineering & Measurement Services, Inc. |
| EPA | U.S. Environmental Protection Agency |
| FORF | Field Observer Report Form |
| FSAD | Field Site Audit Database |
| FSSD | Field Site Survey Database |

**List of Acronyms and Abbreviations (continued)**

| | |
|---|---|
| GPS | Global Positioning System |
| HAL | Mercury Analytical Laboratory |
| Hg | mercury |
| ISWS | Illinois State Water Survey |
| LOTO | lockout tag-out |
| MDN | Mercury Deposition Network |
| NADP | National Atmospheric Deposition Program |
| NIST | National Institute of Standards and Technology |
| NTN | National Trends Network |
| OSHA | Occupational Safety and Health Administration |
| NWS | National Weather Service |
| PDA | Personal Digital Assistant |
| PO | Program Office |
| QA | quality assurance |
| QAPP | quality assurance project plan |
| QC | quality control |
| SOP | standard operating procedure |
| WAAS | wide area augmentation system |

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# 1.0 Scope and Applicability

This Standard Operating Procedure (SOP) describes the procedures for conducting systems surveys of National Atmospheric Deposition Program (NADP) field stations. The NADP is a cooperative, multi-agency program of monitoring stations designed to measure precipitation chemistry and estimate atmospheric deposition of various pollutant ions and mercury. The NADP is comprised of three networks, the National Trends Network (NTN), the Mercury Deposition Network (MDN), and the Atmospheric Integrated Research Monitoring Network (AIRMoN). All three networks of the NADP are focused on long-term monitoring and trends. Various local, state, and federal agencies, as well as universities and other interested groups are responsible for, and contribute to, the operation of the stations.

The purpose of a systems survey is to qualitatively appraise the total measurement system. This includes a thorough, on-site evaluation of facilities, equipment, personnel, training, procedures, documentation, site representativeness and reporting aspects of the field operations systems. Field systems survey results are used to ensure that good quality assurance/quality control (QA/QC) practices are being applied as defined in the NADP Quality Management Plan (QMP). Proper implementation of a survey (or audit) program ensures data integrity and assesses data accuracy.

NADP Site Systems Surveys include:

- Verifying that the site conforms to the characteristics as described in the NADP QMP.
- Verifying that the instruments and equipment are sited, installed, maintained, and operated regarding Occupational Safety and Health Administration (OSHA) compliance.
- Verifying that the instruments and equipment are properly sited, installed, maintained, and operated with respect to project requirements and guidelines.
- Verifying that procedures are in place to ensure that collected data are of sufficient quality to meet the project objectives.
- Verifying that current documentation relating to each component of the measurement system is on-site.
- Observing and evaluating the site operator's proficiency of his/her duties and the understanding of the project goals.
- Recording all information including any sketches or photographs using the appropriate form(s) and Field Site Survey Database (FSSD).
- Recording and reporting any condition that affects data quality or that requires additional attention using the appropriate form(s) and FSSD.
- Distributing survey results, reports, and documentation to the designated project personnel.

## 1.1 Typical NADP Site Installations

The networks of the NADP currently consist of approximately 250 NTN sites, 100 MDN sites, and 7 AIRMoN sites operating throughout the United States, Canada, Puerto Rico, Mexico, and the Virgin Islands. The number and location of operational sites varies at any time. A list of active sites and locations can be found in the "Quality Assurance Project Plan (QAPP) – Support for Conducting Systems and Performance Surveys of National Atmospheric Monitoring Stations" (referred to from this point on as NADP Site Survey Program QAPP). An updated list may be available on the NADP website: http://nadp.sws.uiuc.edu/.

The program goal is to visit and survey approximately 90 sites per year from the three individual networks, and each site in the NADP once approximately every three years. The current survey schedule can be found at ftp://67.192.214.230 in the NADP Final directory.

Specific equipment at each site can vary, but each site will consist of an approved precipitation gage, an approved precipitation collector, a sample weighing device, equipment manuals, approved operating procedures, and site supplies. The approved NADP measurement and sampling equipment includes:

- Belfort 5-780 Mechanical Precipitation Gage
- Aerochem Metrics/Loda (ACM type) NTN Precipitation Collector
- ACM MDN Precipitation Collector
- N-CON Precipitation Collector
- ETI NOAH IV™ Electronic Precipitation Gage
- OTT NADP Pluvio Electronic Precipitation Gage
- National Weather Service (NWS) Stick Precipitation Gage
- Ohaus Mechanical Balance
- Various electronic scales
- Various pH meters and electrodes
- Various conductivity meters and cells

## 1.2 Preliminary Survey Activities

Due to the number and location of the sites in the network, the site systems survey program is a travel intensive project. In order to maintain an efficient schedule and quality product, frequent and concise communication with project personnel is required. Prior to beginning travel, the U.S. Environmental Protection Agency (EPA) Project Officer and site liaisons at the NADP Program Office (PO), the Central Analytical Laboratory (CAL), and the Hg Analytical Laboratory (HAL) must be contacted. Their contact information is listed below:

| | | | |
|---|---|---|---|
| Michael Kolian | 202-343-9261 | kolian.michael@epa.gov | EPA Project Officer |
| Melissa Rury | 202-343-9882 | rury.melissa@epa.gov | EPA Project Officer |
| Mark Rhodes | 217-244-6413 | Rhodes1@illinois.edu | NADP QA Manager |
| Matt Layden | 217-244-0372 | ntn@sws.uiuc.edu | CAL Liaison |
| Roger Claybrooke | 217-244-2838 | dclay@sws.uiuc.edu | NADP PO |
| Doug Disney | 206-622-6960 | dougd@frontiergeosciences.com | HAL Liaison |
| Gerard van der Jagt | 206-622-6960 | gerardj@frontiergeosciences.com | HAL Liaison |
| Jane Rothert | 217-333-7942 | airmon@uiuc.edu | AIRMoN Liaison |

In order to adhere to the schedule set forth in the NADP Site Survey Program QAPP, the above listed personnel must be contacted no less than one month prior to the planned date of the site survey. The initial communication must include the information contained in Table 1 for each planned site survey.

**Table 1. Preliminary Site Communication Information**

| Site Name | Site ID | Survey Date | Previous Survey Date | NADP Network(s) |
|---|---|---|---|---|
| Site #1 | | | | |
| Site #2 | | | | |
| Site #3 | | | | |
| : | | | | |

Information obtained from the NADP liaisons during the preliminary communication should include the information contained in Table 2 below for each site.

**Table 2. Initial Site Information**

| | Existing Information |
|---|---|
| Site operator (name, address, phone, e-mail) | |
| Site supervisor (name, address, phone, e-mail) | |
| Site sponsor contact (name, address, phone, e-mail) | |
| Precipitation gage (manufacturer, model) | |
| Collector (manufacturer, model) | |
| Balance (manufacturer, model) | |
| pH meter (manufacturer, model) | |
| Conductivity (manufacturer, model) | |
| Site characteristics (i.e., solar power, remote, etc) | |
| Known problems (equipment and/or siting related) | |
| Additional requests (training issues, etc) | |
| Logistical concerns (i.e., passes or keys required, etc) | |
| Site sketch available and provided (pdf file name) | |

Figure 1 is an example of the initial site information for site WA14 as received from the NADP PO.

**Figure 1. NADP Pre-Audit Site Information NTN Site WA14**

**National Atmospheric Deposition Program**
**Pre-Audit Site Information**
**NTN Site WA14**

| | | | |
|---|---|---|---|
| Site ID | WA14 | Site Name | Olympic National Park-Hoh Ranger Station |
| Latitude | 47.86 | County | Jefferson |
| Longitude | -123.9319 | Sponsoring Agency | NPS-ARD |
| Elevation | 176 | Operating Agency | NPS-Olympic NP |
| Start | 5/20/1980 | Site Owner | NPS |
| Stop | | Map | Owl Mountain |
| Status | A | | |

**Installed Equipment**

| Wet/Dry Sampler | | Primary Rainguage | | Field Lab | |
|---|---|---|---|---|---|
| Type | ACM | Type | Belfort 5-780 | Scale | Ohaus 1119D |
| Power | AC | Shield | None | pH Meter | Beckman phi 32 |
| Heated | N | Distance to WD | 5.5 | pH Electrode | Broadley-James BNC |
| Lid | F | **Backup Rainguage** | | Cond. Meter | YSI 35 |
| Event Recorder | S | Type | 8 in cylinder | Cond. Cell | YSI 3403 |
| | | Distance to WD | 1.2 | | |

| | Supervisor | Operator |
|---|---|---|
| Name | Bill Baccus | Bill Baccus |
| Phone | 360-565-3061 | 360-565-3061 |
| Alt Phon | | |
| Fax | 360-374-2676 | 360-374-2676 |
| Email | bill_baccus@nps.gov | bill_baccus@nps.gov |
| Training | | |
| | Bill Baccus<br>Olympic National Park<br>600 East Park Avenue<br>Port Angeles, WA 98362-6798 | Bill Baccus<br>Olympic National Park<br>600 East Park Avenue<br>Port Angeles, WA 98362-6798 |

**Funding Agency Representative**

| | | |
|---|---|---|
| Name | Kristi Morris | Kristi Morris<br>National Park Service<br>Air Resources Division<br>12795 W. Alameda Parkway<br>Lakewood, CO 80228 |
| Phone | 303-987-6941 | |
| Alt Phon | | |
| Fax | 303-969-2822 | |
| Email | kristi_morris@nps.gov | |

After obtaining the site contact information from the site liaisons, the site operators and supervisors for each site in the planned trip must be contacted by telephone at least two weeks

prior to the planned site visit. If the planned survey will be the first survey for a particular site (i.e., Previous Survey Date = null), the site sponsor for that site will also be contacted by phone and notified of the survey.

Discussions with the site personnel will include logistics pertaining to accessing the site, date and time of the planned site survey, any modifications that may have been performed on the site instrumentation, and any operational problems that may exist at the site. All relevant information will be added to the data gathered during the preliminary communication with the site liaisons.

Once the initial communication with the site liaisons and site operator has occurred, the comprehensive information obtained for each site will be compiled and included in a Site Survey File.

### 1.2.1 Preliminary Site Survey File

At this point, during the preliminary survey activities, the Site Survey File will contain the compiled comprehensive information obtained during the preliminary communication and data gathering process described above. The information for each site will include records of phone conversations, correspondence, and completed site information data tables.

The file will become a permanent historical record of site survey information and documentation. It will be assigned a Document Control Number (DCN) and will become part of the site survey data management system. Appropriate site information obtained thus far will be entered (or imported) into the FSSD. Initial site data forms will then be generated and included in the Site Survey File and copied and included in the Site Survey Kit to be provided to the Survey Team Member responsible for conducting the site survey.

### 1.2.2 Site Survey Kit

At this step in the systems survey procedures, a Site Survey Kit will be prepared at EEMS. The Site Survey Kit will be assembled utilizing the preliminary information gathered for each site. The site-specific tools, equipment, maintenance items, forms, certification records, Personal Digital Assistant (PDA), field computer with FSSD, and survey supplies required to perform the survey (both performance and systems) of each site in the planned trip will be inventoried and packed for shipment.

Arrangements will be made with the Survey Team Member for the shipment of the kit to the field. Upon receipt of the Site Survey Kit, the Survey Team Member will inspect the kit and report any damaged or missing articles. After completing any additional shipments that may be necessary, the Site Survey Kit inventory and shipping log will be included in the Site Survey File.

The EEMS QA Manager will oversee the process of completing the preliminary Site Survey File, and providing the Survey Team Member with the required materials to complete the planned surveys. Once receipt of the complete and functional survey kit is confirmed by the Survey Team Member, the preliminary Site Survey File is complete. Post-survey information will be included following the site visit and survey by the Survey Team Member.

## 2.0 Summary of Methods

The general qualitative methods used for performing a NADP Site Systems Survey will include the completion of the preliminary survey activities described in the previous sections and then:

- Traveling to the site and verifying that the site information previously obtained is correct
- Verifying that the instruments and equipment are properly sited and installed with respect to project requirements and guidelines by using the site sketch and surveying tools
- Verifying by observation that the site equipment and instruments are properly maintained and operated, and correcting deficiencies where possible
- Verifying by reviewing and observing that procedures are in place to ensure that collected data are of sufficient quality to meet the project objectives
- Verifying by observation that the current documentation for each component of the measurement system is on-site
- Observing and evaluating the site operator's proficiency of his/her duties and the understanding of the project goals
- Recording all information including any sketches or photographs using the appropriate form(s) and FSSD
- Creating backup files and transferring the hardcopy recorded data and the electronic FSSD files to the EEMS data management facility
- Generating the exit report (Spot Report) of the survey activities from the FSSD within 24 hours of completing the survey
- Within 24 hours of completing the survey, verbally reporting the results of the survey to the site liaison with any requests for additional attention or activities to be performed at the site

The methods used to complete the siting criteria evaluation portion of a site systems survey will be the same for all three networks of the NADP. Those methods are by observations and measurements of the direction, distance, height, and width of all objects within a 30 meter radius of the precipitation collector.

Other methods are specific and unique to the measurement and collection equipment and instrumentation at each site.

## 2.1 Instrument Specific Methods

The list of approved NADP site equipment and instrumentation is presented in Section 1.1. The preliminary survey activities identify which of the listed types of instrumentation are present at each site. Table 3 identifies the specific SOP for the performance survey of the equipment or instrumentation type. Some instrument specific systems methods that include routine maintenance are described in the instrument performance SOPs. This SOP includes maintenance and systems checks that are not included in the performance SOPs.

**Table 3. Instrument Specific Methods**

| SOP Name | SOP Number | Revision Number | Revision Date |
|---|---|---|---|
| Belfort 5-780 Mechanical Precipitation Gage | SOP-EPW07061-1400 | 1 | May 2008 |
| OTT NADP Pluvio Electronic Precipitation Gage | SOP-EPW07061-1410 | 1 | May 2008 |
| ETI NOAH IV Precipitation Gage | SOP-EPW07061-1420 | 1 | May 2008 |
| NWS Stick Precipitation Gage | SOP-EPW07061-1430 | 1 | May 2008 |
| ACM NTN Precipitation Collector | SOP-EPW07061-1310 | 1 | May 2008 |
| ACM MDN Precipitation Collector | SOP-EPW07061-1320 | 1 | May 2008 |
| N-CON MDN Precipitation Collector | SOP-EPW07061-1330 | 1 | May 2008 |
| Balance (various) | SOP-EPW07061-1210 | 1 | May 2008 |
| pH meter (various) | SOP-EPW07061-1220 | 1 | May 2008 |
| Conductivity meter (various) | SOP-EPW07061-1230 | 1 | May 2008 |

Using this SOP and those presented in Table 3, a systems survey can be performed at any currently operating NADP site. As new equipment or instrumentation is approved for use at NADP sites, new methods and procedures will be developed for routine maintenance and systems tests of those instruments. Those methods will be incorporated into this SOP and Table 3.

# 3.0 Health and Safety Warnings

The health and safety issues regarding surveys of NADP sites are addressed in the Site Performance Survey SOPs for each network (SOP-EPW07061-1010, SOP-EPW07061-1020, SOP-EPW07061-1030)

# 4.0 Personnel Qualifications

This SOP (and those referenced) is intended to be used by experienced field and instrument technicians. All site survey team personnel are experienced field site specialists with many years of direct involvement with deposition monitoring sites. That involvement includes the installation, repair, maintenance, calibration, and operation of precipitation gages, precipitation collectors, meteorological instrumentation, ambient air samplers, and gaseous analyzers.

Additional training will be provided to the survey team as new instruments and equipment are approved for use in the NADP. Procedures for assessing and evaluating the instrumentation installation, operation, and maintenance will be developed with the cooperation of the NADP and subcommittees.

## 4.1 Training

If training is required at any time during the performance of the NADP Site Survey Program due to changes to personnel, training will be provided by the Survey Team Leader. All new personnel will be trained by accompanying the Survey Team Leader to as many field sites as necessary to become proficient with the survey procedures.

# 5.0 Equipment and Supplies

Together with this SOP, the site specific instrument SOPs listed in Table 3 are required for conducting systems surveys at NADP sites. They are intended to be used by qualified technicians that understand general instrument operation and survey techniques.

## 5.1 Survey Tools and Materials

In addition to the specific instruments and equipment listed in the individual SOPs, the following materials are required to perform NADP site systems surveys.

- NADP QAPP
- Site Survey File for each site in the planned trip
- Hardcopy data forms (forms provided in each Site Survey File)
- Laptop computer with approved FSSD
- Global Positioning System (GPS)
- Miscellaneous recordkeeping supplies
- Miscellaneous cleaning supplies

- Manufacturer's instruction manuals
- Certified compass
- Certified range finder
- Calipers
- Tape measure

# 6.0 Instrument or Method Calibration and Standardization

The methods described in the following sections are separated into categories for similar system survey activities. Where possible analogous systems checks performed on different types of instrumentation are included within the same method. As mentioned in section 2.1, some of the systems checks are directly related to the performance checks and are included in those SOPs. This SOP includes and summarizes the remaining systems checks. The rational and development of those procedures are discussed in the following sections. Survey tools and instruments used as part of this SOP are also carefully calibrated and certified.

## 6.1 Siting Criteria and Site Information

The purpose of these systems checks is to characterize the site and the surroundings. This is critical for data users in order to evaluate data collected at the site and for comparing that data to that of other sites. The general site information gathered during the preliminary phase of data collection regarding site personnel and equipment is verified during these activities.

The site information is verified by observing the site conditions regarding operating equipment, and interviewing the site personnel and comparing those observations to the data provided in the Site Survey File. Data on the forms in the Site Survey File are then accepted or corrected as required. Refer to the Site Information data form included in Appendix A for a complete list of site information data fields. This information will then be delivered to the NADP PO to be incorporated into the site information database. It is anticipated that this information will be updated as necessary by the NADP PO and then provided as part of the preliminary survey information prior to the next survey scheduled for the same site.

### 6.1.1 Siting Criteria Tools and Procedures

Siting criteria checks and site characterization are accomplished by carefully measuring and documenting both the instrumentation and other objects within a 30 meter radius of the precipitation collector. The measurement tools used by the survey team include:

- Certified survey quality compass

- Wide Area Augmentation System (WAAS) GPS
- Certified range finder
- Various measurement devices
- Site survey sketch
- Site Sketch Table
- 4.0 mega pixel (minimum) digital camera
- Directional indicator

The following steps are performed during siting criteria systems checks:

1. Remove and secure any sample collecting media from the collector.
2. Position the lid over the empty dry bucket holder allowing the empty wet bucket holder to be exposed.
3. Determine the location of the collector by positioning the GPS over the wet bucket holder.
4. Remove the GPS and position the compass over the wet bucket holder.
5. From magnetic north and proceeding in a clockwise direction, determine the direction of every object taller than 1 meter and wider than 5 centimeters within a 30 meter radius. Determine the distance to the object using the appropriate measuring device (range finder or other).
6. Verify the site sketch or create a sketch if one is not available.
7. Complete the inventory of other items within a 5 meter radius of the gage and collector as required on the siting criteria data form.
8. Confirm the installation of a wind shield if required.
9. Confirm spatial requirements between gage and collector.
10. Confirm 45 degree rule adherence.
11. Complete the systems data entry forms for all the required fields.
12. Complete the performance tests (use appropriate SOP) and any necessary maintenance as indicated on the data entry forms.
13. Perform the site characterization detailed in section 6.1.2
14. Return the collection media to the proper operating mode.

Refer to the Siting Criteria data form included in Appendix A for a complete list of data fields.

Copies of the calibration/certification documentation for the field test equipment can be found at the EEMS FTP website: ftp://67.192.214.230 in the NADP Final directory.

In order to accurately determine the direction and distance of the objects within the 30 meter radius, certified measurement devices will be used. The compass will be certified annually by an independent laboratory. The range finder will be certified quarterly at the EEMS facility by

comparison with distance measurements using a tape measure. The tape measure will be properly maintained at the EEMS facility in a manner that will preserve its condition. The certification and documentation of these tools will be the responsibility of the QA Manager.

### 6.1.2 Site Characterization

In order to ensure that the site is representative and give data users a sense of the site surroundings, the site must be documented by acquiring digital photographs. Using a digital camera of not less than 4.0 mega pixels, perform the following:

1. Install the directional indicator in place of the wet bucket.
2. Take 8 photographs looking toward the cardinal directions of N, NE, E, SE, S, SW, W, and NW from 5 to 10 meters from the collector.
3. Obtain any additional photographs if necessary to adequately document the site, or site equipment and instrumentation condition. Digital photographs of the sites shall follow a consistent naming convention. Following the site survey all site images will be uploaded to ftp://67.192.214.230 . Current site images can be found at ftp://67.192.214.230 in the NADP Final/Site Files directory.

## 6.2 Routine Maintenance and Minor Repairs

The majority of the required maintenance activities are included in the individual instrument SOPs and documented on the performance survey data forms. Any additional maintenance items contained on the systems data forms must be performed and documented. Those items will include:

- Level and stabilize gages and collectors where possible
- Check and fill Belfort dash pot reservoir
- Assess site power supply and correct any potential issues
- Assess and evaluate the condition of the site instrumentation
- Inventory site manuals and documentation and advise of deficiencies
- Inventory site supplies, document and report any deficiencies

## 6.3 Procedures Assessment

Proper techniques and procedures employed by site personnel are essential for maintaining sample quality. The site operator's procedures must be evaluated as part of a systems survey to assess the quality of the overall measurement system. Record the evaluation and recommendations (if any) on the Site Information data form.

Observe the site operator performing actual sample handling and processing procedures, or provide the site operator with a simulated sample and observe the procedures. Assess the site operator's technique with regard to the procedures provided for the particular equipment and NADP network. Provide assistance and training if necessary adhering to the procedures detailed in the NADP manuals and QAPP.

Evaluate the site operator's technique regarding the interpretation of the precipitation chart if that is part of the site procedures. Provide any necessary training as detailed in the NADP manuals and QMP documentation.

Assess the site operator's recordkeeping procedures and provide assistance and training as detailed in the NADP manuals and QMP documentation.

# 7.0 Troubleshooting

The systems and performance surveys are intended to assess the overall sample and data collection and measurement process. As such, the program procedures will address poorly or malfunctioning site instrumentation. Routine maintenance and minor repair of the site equipment will be performed to continue or restore the operation to the NADP specifications. In order to perform this function some troubleshooting of malfunctioning equipment or instrumentation may be necessary. The instructions provided to site operators by the NADP PO and the manuals provided by the instrument manufacturers will be utilized to perform the troubleshooting procedures. The experience of the site Survey Team Member will ensure exceptional troubleshooting techniques.

The list of items that are routinely addressed during the survey is included in Table 6 of the NADP Site Survey Program QAPP.

## 7.1 Site Survey Instrument Function

The tools, instruments, standards, and materials that make up each Site Survey Kit are carefully controlled, tested, calibrated and maintained by the EEMS QA staff. This process is intended to ensure proper and accurate function when the kit is used in the field. Should any of the items malfunction during a site survey trip, troubleshooting will be performed in the same manner by the site survey team with the assistance of the EEMS QA Manager.

If any field repairs are performed on items in the survey kit, the EEMS QA Manager will determine if the certification of that item and survey results measured by that item are

compromised. If necessary a replacement item will be sent to the Survey Technician from the EEMS facility to ensure accurate survey results.

# 8.0 Data Acquisition, Calculations, and Reduction

Data acquisition at most NADP sites is accomplished by visual observations, made by site operators, and site instrument measurements on hardcopy media (rain gage charts). These are manually recorded to hardcopy forms by the site operator and then sent to the CAL. As electronic precipitation gages are deployed at NADP sites, data acquisition will be accomplished by radio transmission to handheld data devices and then electronically sent to the CAL. Some sites will also employ direct telemetry from the site equipment to the CAL.

Data acquisition for systems surveys of NADP sites will be accomplished by recording the information described in the previous sections onto data forms. Recorded data will then be entered into the FSSD as described in the following sections.

## 8.1 Post-Site Survey Procedures

At this point the information gathered during the site survey will be recorded on the data forms associated with data collection for each measurement process or system. The data forms comprise the complete Site Survey Questionnaire which is included in Appendix B.

The recorded data must be entered into the FSSD and used to generate reports and database files that can be used by the EPA, the NADP PO, and other data users. The method and tasks to be completed after recording survey data are described in the following sections.

### 8.1.1 Data Entry

The FSSD is a Microsoft Access® 2003 application. The database is a relational set of data tables that are designed to store records of the data recorded during the site survey. Data are entered into the data tables using data entry forms. The forms are similar to the hardcopy forms provided in the each SOP. The forms and menus are presented in the following sections. A complete description of the FSSD can be found in the FSSD User's Manual.

#### 8.1.1.1 User Type Selection Menu

Because the FSSD is used by field personnel as well as office personnel, two sets of forms, functions, reports and tables exists, one for field use and one for office use. The first screen viewed when the FSSD is opened is a screen which allows access to either

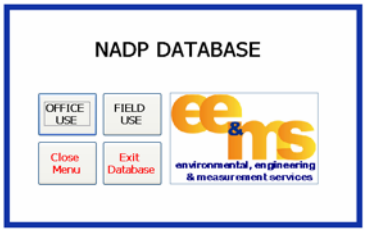



**Figure 2. User Type Selection Menu**

office personnel or field personnel to the corresponding forms, function and repots. Figure 2 shows this first screen.

#### 8.1.1.2 NADP Survey Database – Office Version Main Menu

The buttons on the Office Version main menu provide access to reports and forms contained in the database. Figure 3 shows the different options the user can choose from:

- Import Preliminary Data
- Generate Field Forms
- Import Field Data
- Site Selection Form
- Enter Survey data
- Run QA/QC Checks
- Export Field Data
- Preview Reports
- Prepare EDD for NADP
- Database Maintenance

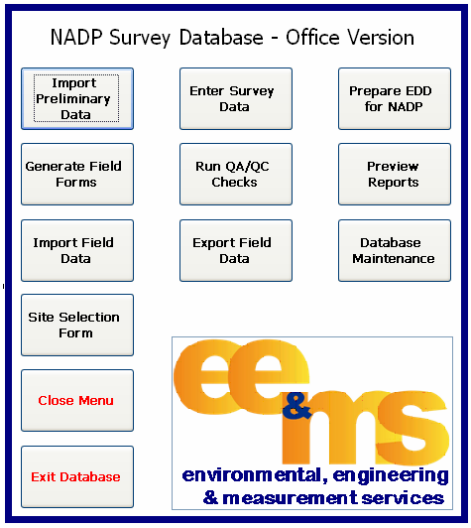



**Figure 3. NADP Survey Database – Office Version Main Menu**

#### 8.1.1.3 NADP Survey Database – Field Version Main Menu

The Field Version of the NADP Survey Database provides fewer options than the Office Version given that there are a number of functions that are not performed in the field, or by field personnel. The buttons on the Field Version main menu provide access to reports and forms contained in the database. Figure 4 shows the different options the user can choose form:

- Generate Field Forms
- Enter Survey Data
- Export Field Data
- Preview Spot Report
- Database Maintenance

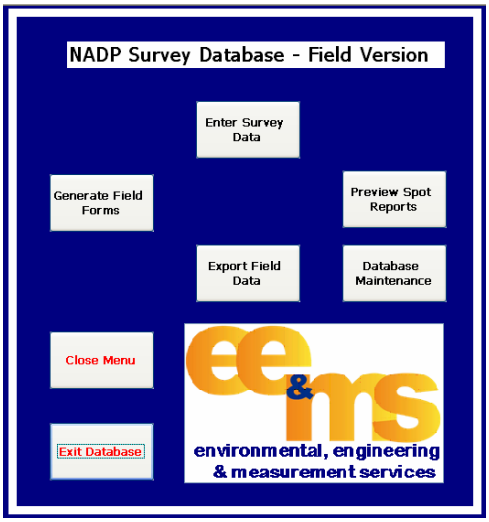



**Figure 4. NADP Survey Database – Field Version Main Menu**

### 8.1.1.4 Enter Survey Data

The Enter Survey Data menu (Figure 5) allows the user to select the site and form for which to enter data. This menu provides the user with the following options:

- Site Selection Form
- Site Information Form
- Siting Criteria Form
- Belfort Gage Form
- Electronic Gage Form
- NWS Stick Gage Form
- ACM Collector Form
- N-CON Collector Form
- Backup Raingage Form
- Field Laboratory Form
- Field Supplies Form
- Site Object Form

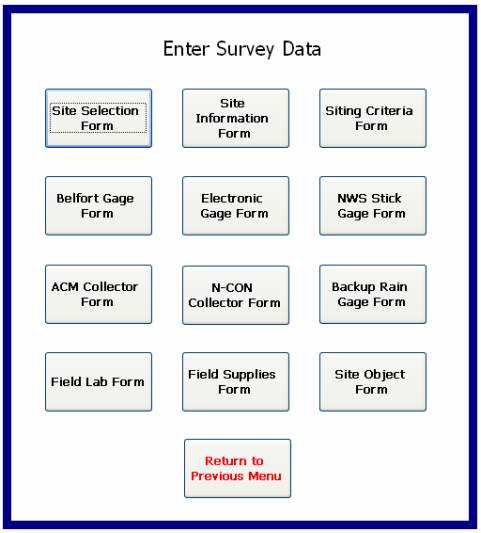



**Figure 5. Enter Survey Data Menu**

### 8.1.1.5 Typical Data Entry Form

From the Enter Survey Data Menu the user can select from a number of forms. The one shown in Figure 6 is the Site Information Form used by field personnel. The station ID, network, site name, operator information and other general information pertaining to the site is included in this form. For the most part these forms consist of a number of questions for which the user must select the most appropriate answer from a drop-down menu. However there are some questions that require a numeric input or a text input that is not a drop-down selection. Those fields highlighted in blue constitute data that is then include in the site Spot Report.

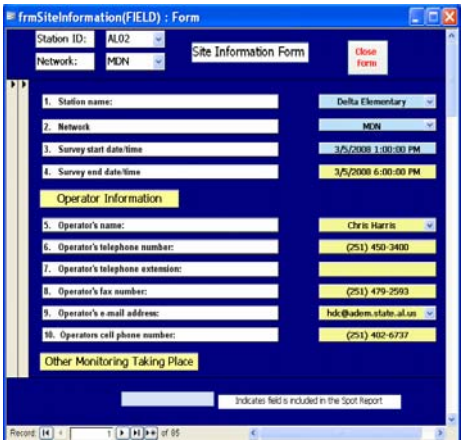



**Figure 6. Site Information Form (Field Form)**

### 8.1.1.6 Preview Report Menu

From this menu the user can select the site and report from the following options (Figure 7):

- Revised Spot Reports
- Site Survey Reports
- Field Spot Report
- QA Report

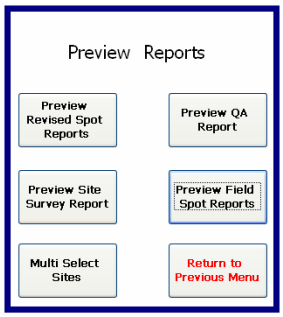



**Figure 7. Preview Reports Menu**

## 8.2 Manual Data Acquisition

The site operators are required to interpret the hardcopy charts and calculate the daily and weekly total precipitation on the various network observer report forms. Those procedures will be verified and assessed as part of the systems survey. The calculations performed by the site operator will be checked for accuracy as part of the site systems survey.

## 8.3 Electronic Data Acquisition

Electronic data recorded by the measurement devices that utilize those methods will be checked as part of the performance survey. The survey tests will account for the combined error from both the measurement instrument and the internal data acquisition system (DAS).

Where possible the transfer of the electronic data from the internal DAS to the handheld device will be verified as part of the systems survey. The verification will include checks for completeness and accuracy. This may be accomplished by manually transferring data from the DAS to the site survey computer and comparing that file to data transferred automatically to the handheld device.

## 8.4 Data Entry and Verification of Calculation Results

Upon completion of the site performance survey, data recorded on the survey data forms will be entered into the FSSD. The database will perform automatic calculations from the data entered, and those results will be compared to results obtained by the manual calculations.

Any discrepancies observed will be resolved by the site Survey Technician at the time of data entry. This procedure serves as the first review and verification of survey results. Additional review, verification, and validation processes are described in Sections 10.0 and 11.0.

## 8.5 Spot Report Generation and Distribution

Following data entry the Survey Technician will generate a Portable Document Format (PDF) Spot Report from the FSSD report menu which summarizes the activities performed during the site survey. Required site supplies and Instruments that require additional attention are highlighted. The spot report is distributed to the site operator, site supervisor, NADP QA Manager, EPA Project Officer, EEMS Project Manger, and the EEMS QA Manager.

# 9.0 Computer Hardware and Software

Computer hardware and software are not used by the NADP to collect data at the sites. Some sites utilize handheld data devices as previously described, and their use is anticipated to increase as more electronic gages are installed.

Site survey data will be recorded on hardcopy forms and then entered into a database installed on a field laptop computer.

## 9.1 Field Laptop Computer

The Survey Team Member will have an IBM® compatible field laptop computer to be used to record and manage the site survey data. The laptop will be suitable for field use in terms of battery operation, portability, and sturdiness.

## 9.2 Computer Software

The field computer will have a Microsoft Windows® operating system. Microsoft Office® and Microsoft Access® will be used to develop the FSSD which will be the database used to manage the survey results. The FSSD and examples of the types of forms and screens have been discussed in Section 8.0 and subsections.

After data entry is completed, the required Spot Report can be generated and distributed. This will contain the maintenance items required (if any) at the site. The electronic data tables will also be generated and exported to the duplicate database at EEMS.

### 9.2.1 Field Data Backup

Each Site Survey Kit will contain a "thumb drive" (or flash) memory device capable of storing all the data tables containing the survey data, and digital photos acquired during the site survey trip. After entering the survey data for each site, all data will be copied to the thumb drive for backup. This procedure will continue for each site in the survey trip. At the conclusion of the trip, the thumb drive will be sent, together with the final hardcopy data forms from the last site visited, to EEMS. The field computer which at this point also contains a copy of the same information will be sent to EEMS separately. Prior to the field computer and Site Survey Kit being sent back to EEMS, two copies of the site survey data tables and all other information (digital photos, electronic reports, etc) will be written to compact disc (CD). One disc will be included with the Site Survey Kit and returned to EEMS, and one disc will be kept by the Survey Technician for his or her records.

# 10.0 Data Management and Records Management

Most of the data and records management procedures have been discussed throughout the previous sections. Particularly the preliminary Site Survey File data gathering process and the field site survey data gathering and management processes. This section and subsequent subsections describes the management of the final site survey data and Site Survey File at EEMS.

## 10.1 Shipping and Tracking

As mentioned in Subsection 1.2.2, prior to conducting site visits, the Site Survey File will contain all the preliminary information gathered, and the record of shipment and receipt of the Site Survey Kit. As information is received at EEMS following site visits, the information will be logged and that record will be added to the Site Survey File.

The QA Manager will oversee the process of receiving the electronic data export from the field and the importation of that data into the duplicate database at EEMS. After the original hardcopy data forms have been received and logged the duplicate data entry process will begin.

## 10.2 Duplicate Data Entry and Reconciliation

As a QC check, duplicate data entry will be performed for designated site survey data fields, most of which will be numeric data results. The intention of duplicate data entry is to minimize typographical errors. Theoretically it is unlikely for two different people to make the same mistake when entering the same data. Therefore by comparing both entries the mistakes made during each entry will be identified. The duplicate entry will be performed at EEMS by personnel other than the site Survey Team Member. The entry will be overseen by the QA Manager.

Following the duplicate data entry process the data tables will be automatically compared for differences. Any difference will automatically be flagged for further investigation. The QA Manager will be responsible for reconciling any differences by reference to the original hardcopy data form or discussion with the Survey Team Member or site operator.

A record of the differences found and the resolution of the differences will be added to the Site Survey File and included in the monthly progress and management reports. If for any reason a difference cannot be resolved, it will be identified for further action and all actions will be reported in monthly progress reports.

## 10.3 Final Data Set

After the QA manager has ensured that all of the steps described above have been performed and has approved the site survey data tables, the site survey data will be considered final. At this stage in the data management process following entry of each and every site survey data set, the database will be backed up to an external hard drive on-site and off-site.

### 10.3.1 Site Survey Performance Report

From the final data set, a Site Survey Performance Report is generated and distributed for each site survey. This report will address any differences that may have been reported in the Spot Report. The Project Manager will be responsible for generating and distributing this report. The electronic Site Survey Performance Reports will be delivered within 15 days from the site survey. Other hardcopy information such as edited site sketches will be mailed to the NADP PO. Copies of all information will be retained and added to the Site Survey File.

Following delivery of the Site Survey Performance Report and any hardcopy information, the Site Survey File for the completed site will be closed and archived. The DCN will indicate the Site ID, Network ID, and the date of the survey to allow for retrieval if requested. A new Site Survey File will be initiated at least one month prior to the next scheduled site survey.

### 10.3.2 Electronic Data Delivery

Electronic data delivery (EDD) files will be delivered with the monthly progress reports for those months when site surveys were conducted. The format of the EDD will be developed with the assistance of the NADP PO and suitable for import into the NADP database. The electronic data files will contain all of the information included in the Site Survey Performance Report. The EDD files will also contain all other digital information collected during the site survey such as digital photographs.

# 11.0 Quality Control and Quality Assurance

EEMS is acutely aware that the NADP Site Survey Program is one QA/QC role of the NADP program. As such, the internal site survey program QA/QC has added importance and consequence since not only data collected for the purpose of the survey, but data collected for the purpose of the NADP are jeopardized if the survey data are not accurate and quality assured.

The EEMS personnel and Survey Team Members are aware of the significance of the survey program and the impact of the data collected. They are all experienced professionals and dedicated to the programs of the NADP and EPA Clean Air Markets Division. The following

sections describe the quality process that is not only employed for NADP site survey procedures, but for all projects at EEMS.

## 11.1 Review Verification and Vigilance

The NADP Site Survey Program management structure ensures that sufficient review and QA/QC procedures are applied. Prior to conducting any field work all procedures are documented and reviewed by experts in the field of deposition and precipitation monitoring. The consultants selected to assist with the quality assurance of the documentation and survey program are Dr. Peter Finkelstein and Scotty Dossett.

As described in the previous sections throughout this SOP all data collected are reviewed and verified during the survey and data management process. This begins with the preparation of the survey kit materials for the site Survey Team Member.

Review and verification continue during the survey process. By requiring the Survey Team Member to write the observations and results on hardcopy forms and then read the forms while entering the information into the FSSD, a first review is performed. Since this is accomplished while the Survey Team Member is at, or near the site, any discrepancies can be addressed by double-checking the test of the instrument or the site observation.

Verification and vigilance continue as data are transmitted to EEMS. The duplicate entry procedures verify that the recorded data are correctly entered into the database. This process is overseen and reviewed by personnel that have not collected or entered the data, which provides an independent check.

## 11.2 Reporting and Accountability

All personnel are informed and encouraged to report any discrepancy or deficiency that may exist in the survey results or site survey procedures. This began with the review of the documentation as described and the incorporation of comments and suggestions. The process will continue as the project goes forward and data are collected. Improvements to the procedures will be presented in reports to management for approval prior to any implementation.

If at any time during the review and verification process any employee or consultant feels that data quality may be compromised due to deficient or inaccurate oversight procedures, they will report the concern and condition to the QA Manager, the Project Manager, and the EPA Project Officer. If the condition is not satisfactorily addressed, the QA Manager has the authority to stop work on the project until the condition is resolved.

### 11.2.1 Active Communication

It is the management philosophy of EEMS that quality starts with communication. By actively involving all project participants during regular meetings, all quality concerns are brought forth and addressed. Open communication is also encouraged between EEMS personnel, consultants, NADP personnel, and EPA personnel. The project management will be transparent with all aspects of the program available for data users, NADP and EPA clients for examination.

All project personnel are reminded that they are accountable. They are encouraged to actively communicate with clients to ensure quality issues are addressed and a quality product is produced.

# Appendix B.

# Site Performance Survey Questionnaire

# Site Information Field Form

Station ID: NC41

Network: NTN

| | On File Value | Updated Value |
|---|---|---|
| 1. Station name: | Finley Farm | |
| 2. Network: | NTN | |
| 3. Survey start date/time: | | |
| 4. Survey end date/time: | | |

OPERATOR INFORMATION

| | | |
|---|---|---|
| 5. Operator's name: | Erin Silva | |
| 6. Operator's telephone number: | 919 515-9496 | |
| 7. Operator's telephone extension: | | |
| 8. Operator's fax number: | | |
| 9. Operator's email: | esilva@mindspring.com | |
| 10. Operator's cell phone number: | | |

| OTHER MONITORING TAKING PLACE | On File Value | Updated Value |
|---|---|---|
| 11. Does site conduct other environmental data collection | | |
| 12. Non - NADP precipitation chemistry | | |
| 13. Gas monitoring - SOx / NOx / CO / etc. | | |
| 14. IMPROVE | | |
| 15. CASTNET | | |
| 16. AIRMoN - dry deposition station | | |
| 17. PM-10, PM-2.5, TSP | | |
| 18. UV-b | | |
| 19. SURFRAD | | |
| 20. CRN (Climate Reference Network) | | |
| 21. NWS (National Weather Service) | | |
| 23. NEON (National Ecological Observatory Network) | | |
| 22. Other weather monitoring | | |
| 24. Specify other weather monitoring program: | | |

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

25. Other environmental monitoring?

26. Specify other environmental monitoring program:

## OTHER INFORMATION

27. Survey cancelled due to precipitation? YES NO

28. Precipitation during visit? YES NO

29. Date of rescheduled survey: NOT APPLICABLE

30. Ambient temperature - deg. C

31. Does site report daylight savings time on FORF? YES NO

32. EEMS field team leader: ERIC HEBERT SANDY GRENVILLE SCOTTY DOSSETT

## POWER SUPPLY

33. Electrical connections are in good condition YES NO NOT APPLICABLE MISSING UNABLE TO TEST

34. Collector connected to a GFCI circuit YES NO NOT APPLICABLE MISSING UNABLE TO TEST

35. Power supply AC DC AC/DC

36. Solar power YES NO NOT APPLICABLE MISSING UNABLE TO TEST

37. Indicate solar output capacity (Watts): -39 -69 -99

38. Solar panel operating properly, no further maintenance is needed YES NO NOT APPLICABLE MISSING UNABLE TO TEST

## OPERATOR TECHNIQUE FOR CHANGING SAMPLES

39. Is sampling media quality maintained YES NO NOT APPLICABLE MISSING UNABLE TO TEST

40. Operator is competent YES NO NOT APPLICABLE MISSING UNABLE TO TEST

41. No CAL/HAL follow-up needed with operator on technique/training YES NO NOT APPLICABLE MISSING UNABLE TO TEST

42. Does operator check sensor heater before _after collector opening? YES NO NOT APPLICABLE MISSING UNABLE TO TEST

43. Is recordkeeping adequate YES NO NOT APPLICABLE MISSING UNABLE TO TEST

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

Comments on site information:

Feedback from site operator:

Other attendees names and titles:

Comments on site power:

# Siting Criteria Field Form

**Station ID** NC41

**Network:** NTN

| | On File Value | Updated Value |
|---|---|---|
| 1. Site Type | | URBAN / SUBURBAN / RURAL / ISOLATED / SPEICAL RESEARCH |
| 2. Is the orifice of the collector +/- .3 m of raingage (elevation) | | YES NO |
| 3. Distance from collector to primary raingage (meters) | 5.6 | |
| 4. Raingage mounting | | GROUNDLEVEL / PLATFORM / BUILDING / OTHER |
| 5. Height of raingage (meters) | 0 | |
| 6. Raingage ground cover, 30 m radius | | NATURAL / ARTIFICIAL / NATURAL & ARTIFICIAL |
| 7. 45 degree rule met (raingage) | | YES NO |
| 8. If raingage mounting is Building, is 30 degree rule met | | YES NO N/A |
| 9. 30 degree rule for trees met (raingage) | | YES NO |
| 10. 30 degree rule for buildings met (raingage) | | YES NO |
| 11. No objects > 1 m height inside 5 m radius (raingage) | | YES NO |
| 12. No fences > 1 m height inside 2 m radius (raingage) | | YES NO |
| 13. No vegetation height > 0.6 m within 5 m radius (raingage) | | YES NO |
| 14. Does NADP require a raingage wind shield at this site | NO | YES NO |

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

| | On File Value | Updated Value |
|---|---|---|
| 15. If raingage wind shield present, is it installed correctly | | YES NO N/A |
| 16. Raingage wind shield type | | NONE<br>ALTER TYPE<br>OTHER |
| 17. Collector mounting | | GROUNDLEVEL<br>PLATFORM<br>BUILDING<br>OTHER |
| 18. Height of collector (meters) | 0 | |
| 19. Collector ground cover, 30 m radius | | NATURAL<br>ARTIFICIAL<br>NATURAL & ARTIFICIAL |
| 20. Collector and sensor oriented properly | | YES NO |
| 21. If collector and sensor are not oriented properly, was orientation corrected | | YES NO N/A<br>MISSING<br>UNABLE TO TEST |
| 22. 45 degree rule met (collector) | | YES NO |
| 23. If collector mounting is Building, is 30 degree rule met | | YES NO N/A<br>MISSING<br>UNABLE TO TEST |
| 24. 30 degree rule for trees met (collector) | | YES NO |
| 25. 30 degree rule for buildings met (collector) | | YES NO |
| 26. No objects > 1 m height within 5 m radius (collector) | | YES NO |
| 27. No fences > 1 m height inside 5 m radius (collector) | | YES NO |
| 28. No vegetation height > 0.6 m within 5 m radius (collector) | | YES NO |
| 29. No sources of treated lumber inside 5 m radius (collector) | | YES NO N/A<br>MISSING<br>UNABLE TO TEST |

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

| | On File Value | Updated Value |
|---|---|---|
| 30. No galvanized metal inside 5 m radius (MDN collector) | | YES NO N/A MISSING UNABLE TO TEST |
| 31. No pastures and agricultural activity within 20 m radius | | YES NO N/A MISSING UNABLE TO TEST |
| 32. No herbicides and fertilizers used within 20 m radius | | YES NO |
| 33. Collector snow roof present | | YES NO |
| 34. If collector snow roof present, is it present year round | | YES NO N/A |
| 35. Roads meet NADP siting criteria | | YES NO |
| 36. Waterways meet NADP siting criteria | | YES NO |
| 37. Airports meet NADP siting criteria | | YES NO |
| 38. Animal operations meet NADP siting criteria (NTN and AIRMoN only) | | YES NO N/A |
| 39. Combustion sources meet NADP siting criteria (MDN only) | | YES NO N/A |
| 40. Parking lots and maintenance areas meet NADP siting criteria | | YES NO |
| 41. Storage areas (fertilizers, road salt, manure, etc) meet NADP siting criteria | | YES NO |
| 42. Metalworking operations meet NADP siting criteria (MDN only) | | YES NO N/A |
| 43. GPS site latitude - decimal degrees | 35.7288 | |
| 44. GPS site longitude - decimal degrees | -78.6802 | |
| 45. GPS site altitude - meters | 120 | |
| 46. Indicated GPS accuracy - meters | 3 | |
| 47. No significant changes to local site conditions within 500 meters of the collector since previous survey | | YES NO |

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

| | On File Value | Updated Value |
|---|---|---|

Comments on siting criteria including recommendations for improvement:

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

# ACM Collector Field Form

Station ID: NC41

Network: NTN

| | On File Value | Updated Value |
|---|---|---|
| 1. Does collector cycle under battery power | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 2. Has linear actuator been installed | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 3. Were the correct fuses found | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 4. Were all fuse problems corrected during survey | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 5. Battery capacity - cold crank amps | | -39 -69 -99 |
| 6. Batteries in good condition | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 7. Order replacement ACM battery | | YES NO |
| 8. Battery pass load test | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 9. Precipitation collector Manufacturer | ACM | ACM LODA |
| 10. Heated base in winter | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 11. Heated arms in winter | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 12. Heated lid in winter | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 13. Correct counter weight | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 14. Are boots used for lid arms | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 15. Base not enclosed to ground | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 16. Is collector level | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 17. If collector is not level, was collector leveled | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 18. Is collector stable | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 19. If collector is not stable, was collector stabilized | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 20. Number of tie down springs needed (if required) | | -39 -69 -99 |
| 21. Is drive rod straight | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 22. Was arm alignment lubricated (NTN and AIRMoN) | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 23. Distance ground to top of bucket - meters | -39 | -39 -69 -99 |
| 24. Dry side bucket is clean | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 25. Dry side bucket or bag is changed | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 26. Does lid seal properly | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

| | | | | | | |
|---|---|---|---|---|---|---|
| 27. Lid liner in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 28. Dry bucket holder height (inches) | -39 | | | -39 | -69 | -99 |
| 29. Wet bucket holder height (inches) | -39 | | | -39 | -69 | -99 |
| 30. Blue clip in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 31. Arm boots in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 32. Chimney cap in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 33. Does collector have a motor box inspection door | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 34. Fan in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 35. Cooling fan thermostat in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 36. Heater in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 37. Heater thermostat in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 38. Has flush wall filter mount been installed | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 39. Filter in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 40. Lab jack in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 41. Overflow bucket in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 42. Graduated cylinder in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 43. Indicated temperature on max / min thermometer (oF) | | | | -39 | -69 | -99 |
| 44. Survey team's temperature reading (oF) | | | | -39 | -69 | -99 |
| 45. Max / min thermometer in acceptable limits | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 46. Is 'as found' caulk around chimney in good condition | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 47. Was chimney recaulked by survey team | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 48. Dry side bag installed correctly | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 49. Correct sensor grid type | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 50. Does sensor respond to a drop of water | | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 51. Temperature of sensor inactivated (deg. C) | | | | -39 | -69 | -99 |
| 52. Maximum temperature = <10 minutes (deg. C) | | | | -39 | -69 | -99 |
| 53. Time to Maximum temperature = <10 minutes | | | | -39 | -69 | -99 |
| 54. Sensor operates properly | | YES | | NO | | UNABLE TO TEST |
| 55. Order replacement ACM sensor | | | | YES | | NO |
| 56. Voltage of motorbox at E.R. terminal (collector closed) | | | | -39 | -69 | -99 |

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

| | | | | | |
|---|---|---|---|---|---|
| 57. Voltage of motorbox at E.R. terminal (collector open) | | -39 | -69 | -99 | |
| 58. Voltage of raingage E.R. terminal (collector open) | | -39 | -69 | -99 | |
| 59. Clutch lift 2 raingage weights | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 60. Motorbox operates within acceptable limits | YES | NO | UNABLE TO TEST | | |
| 61. Order replacement ACM motorbox | YES | NO | | | |

Describe any alterations to collector by site operator:

Other adjustments made to collector by survey team:

Follow-up corrections needed for collector:

Comments on ACM type collector:

Comments on ACM type sensor and motorbox:

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

# Belfort Gage Field Form

Station ID: NC41

Network: NTN

| | | | | | |
|---|---|---|---|---|---|
| 1. Is 8 inch orifice round | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 2. Does site have raingage funnel | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 3. Is gage level | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 4. If gage is not level, was it re-leveled | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 5. Is gage stable | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 6. If the gage is not stable, was it stabilized | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 7. Clock operates properly 'as found' | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 8. E.R. solenoid operates properly 'as found' | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 9. No dashpot fluid added | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 10. Order dashpot fluid | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 11. Order raingage ink | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 12. Order replacement pen nibs | 0 | | 1 | 2 | 3 |

| Standard Weights Added | Equivalent Height | As Found | Post Calibration Equivalent Height | As Left |
|---|---|---|---|---|
| Baseline gage reading inches | | | | |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |
| 12 | | | | |

Enter -39 in numerical fields for items that are "NOT APPLICABLE"

Enter -69 in numerical fields for "UNABLE TO TEST ITEM"

Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

| | | | | | |
|---|---|---|---|---|---|
| 13. Was the 'as found' zero plate set properly | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 14. Was the 'as found' turn over set properly | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 15. Was the 'as found' event recorder set properly | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 16. Order replacement gage | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 17. Has Belfort " RED " knob modification been made | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |

18. Comments on Belfort raingage (include any repairs and adjustments)

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

# Field Laboratory Field Form

Station ID: NC41

Network: NTN

| | | | | | |
|---|---|---|---|---|---|
| 1. Does site conduct field chemistry | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 2. Is laboratory temperature controlled | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 3. pH meter simulation test 7.00 | | | | | |
| 4. pH meter simulation test 4.00 | | | | | |
| 5. Acceptable conductivity measurement techniques | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 6. Target conductivity of audit sample | | | | | |
| 7. Measured conductivity of audit sample | | | | | |
| 8. Acceptable pH measurement techniques | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 9. Target pH of audit sample | | | | | |
| 10. Measured pH of audit sample | | | | | |
| 11. Order pH probe | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 12. Good weighing practices | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |

| | Standard Weight | Scale Response |
|---|---|---|
| 13. Calibration Std.Wt. (821g) | | |
| 14. Calibration Std.Wt. (1643g) | | |
| 15. Calibration Std.Wt. (2466g) | | |
| 16. Calibration Std.Wt. (3288g) | | |

| | | | | | |
|---|---|---|---|---|---|
| 17. Are samples stored and shipped properly | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 18. Temperature of blank bottles in refrigerator | | | | | |

Field Lab Comments: No comments

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

# Site Supplies Field Form

Station ID: NC41

Network: NTN

## Clean Supplies

1. MDN Coolers
2. Unused buckets in bags, ready to be used
3. Unused bucket lids in bags, ready to be used
4. Unused 1-L sample bottles in bags, ready to be used
5. Unused 250-mL sample bottles in bags, ready to be used (AIRMoN)

## NTN Shipping Boxes

6. Large shipping boxes
7. Small 1-L bottle boxes

## Used Supplies

8. Wet side used buckets, do not include dry side or discard buckets
9. Used bucket lids
10. Used 1-L sample bottles
11. Used 250 mL sample bottles (AIRMoN)
12. No used collector and raingage components on hand — YES NO UNABLE TO TEST
13. Sample mailers on hand Black Box w/blue tape
15. Ice Packs
14. Temperature blank bottles on hand

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

## Supplies Needed

| | | | | | |
|---|---|---|---|---|---|
| 16. Order Site Operations Manual/SOPS | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 17. Order raingage manual | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 18. Order copy of training video | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 19. Order wash bottle | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 20. Order deionized water | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 21. Order disposable towels | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 22. Order 4 ml polystyrene sampling vials | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 23. Order vial style | NONE | SHORT | LONG | NOT APPLICABLE | |
| 24. Order pH 4.0 buffer solution | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 25. Order pH 7.0 buffer solution | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 26. Order specific conductance standard | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 27. Order 4.3 Quality control check sample | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 28. Order electrode fill solution | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 29. Order blank field forms | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 30. Order blank raingage charts | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 31. Order NADP vial holder | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 32. Order NADP vial holder cover | YES | NO | NOT APPLICABLE | MISSING | UNABLE TO TEST |
| 33. Order gloves | NONE | SMALL | MEDIUM | LARGE | |

34. Comments on supplies needed:

Enter -39 in numerical fields for items that are "NOT APPLICABLE"
Enter -69 in numerical fields for "UNABLE TO TEST ITEM"
Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

# Backup Raingage Field Form

Station ID: NC41

Network: NTN

| | | |
|---|---|---|
| 1. Type of backup gage within 30 m of NADP collector | None | TIPPING BUCKET<br>STICK<br>BELFORT<br>NOAH IV<br>OTT<br>OTHER |
| 2. Is the orifice of the collector +/- .3 m of backup raingage | | YES NO |
| 3. Distance from collector to backup raingage (meters) | -39 | |
| 4. Backup raingage ground cover, 30 m radius | | NATURAL<br>ARTIFICIAL<br>NATURAL + ARTIFICIAL |
| 5. 45 degree rule met (backup raingage) | | YES NO |
| 6. If backup raingage mounting is Building, is 30 degree rule met | | YES NO N/A |
| 7. 30 degree rule for trees met (backup raingage) | | YES NO |
| 8. 30 degree rule for buildings met (backup raingage) | | YES NO |
| 9. No objects > 1 m height inside 5 m radius (backup raingage) | | YES NO |
| 10. No fences > 1 m height inside 2 m radius (backup raingage) | | YES NO |
| 11. No vegetation height > 0.6 m within 5 m radius (backup raingage) | | YES NO |
| 12. If backup raingage wind shield present, is it installed correctly | | YES NO NOT APPLICABLE MISSING UNABLE TO TEST |
| 13. Backup raingage wind shield type | | NONE ALTER TYPE OTHER |

14. Backup gage comments:

Enter -39 in numerical fields for items that are "NOT APPLICABLE"

Enter -69 in numerical fields for "UNABLE TO TEST ITEM"

Enter -99 in numerical fields for items with a "MISSING VALUE"

Indicates item included in Spot Report

# Object Field Form

**Station ID: NC41**

**Network: NTN**

| Object Description | Azimuth (degrees) | Distance (meters) | Length (meters) | Width (meters) | Height (meters) |
|---|---|---|---|---|---|
| PLANT CHAMBER | 9 | 23.2 | | | |
| POST | 43 | 22.5 | | | |
| POST | 49 | 16.6 | | | |
| PLANT CHAMBER | 68 | 17.0 | | | |
| PLANT CHAMBER | 68 | 25.4 | | | |
| BELFORT | 407 | 5.4 | | | |
| END OF WOOD FENCE | 111 | 27.5 | | | |
| EDGE OF SCRAP PILE | 113 | 24.6 | | | |
| METAL BOX | 131 | 27.8 | | | |
| TREE | 289 | 28.2 | | | |
| POST | 295 | 8.7 | | | |
| PLANT CHAMBER | 254 | 23.0 | | | |
| NTN COLLECTOR | 0 | 0.0 | | | |
| PLANT CHAMBER | 27 | 22.1 | | | |
| POST | 35 | 22.5 | | | |
| POST | 38 | 16.6 | | | |
| PLANT CHAMBER | 54 | 17.0 | | | |
| BELFORT | 95 | 5.4 | | | |
| END OF WOOD FENCE | 98 | 27.5 | | | |
| EDGE OF SCRAP PILE | 127 | 25.1 | | | |
| EDGE OF PLOWED FIELD | 145 | 20.2 | | | |
| EDGE OF PLOWED FIELD | 207 | 19.4 | | | |
| POST | 289 | 8.7 | | | |

| Object Description | Azimuth (degrees) | | Distance (meters) | | Length (meters) | Width (meters) | Height (meters) |
|---|---|---|---|---|---|---|---|
| PLANT CHAMBER | 354 | | 23.0 | | | | |

## Other Objects

| | | | | | |
|---|---|---|---|---|---|
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